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ABSTRACT

The research reported pertains to the interrelationships of the economic system, the health-care delivery system, and the health manpower education systems. In this research it was learned that in a part of the intermountain region predominately rural in nature, the economic and the health systems are closely related. Challenge is given to the traditional usage of practitioner/population ratios, while a rationale is provided for concentrating on communities and economic trade areas for planning purposes rather than using political-geographic jurisdictions. A second and important part of this research was the estimation of the interrelationships of the health manpower education system with the economic and health-care delivery systems. The results varied between inconclusive and fruitless; in view of the lack of fundamental information on the nature of health manpower eduction programs, additional research in three target areas is recommended before it can be meaningful to suggest the optimal location of programs. (Statistical data are included in the body of the report, represented in tables and maps; further data are appended, as are health and economic bibliographies.) (AJ)

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The Delineation of
ECONOMIC & HEALTH SERVICE AREAS
&
And The Location of
HEALTH MANPOWER EDUCATION PROGRAMS

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The Delineation of ECONOMIC & HEALTH SERVICE AREAS

And The Location of HEALTH MANPOWER EDUCATION PROGRAMS

Prepared by

Division of Business and Economic Research
College of Commerce and Industry
University of Wyoming
Laramie, Wyoming

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DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
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PREFACE

In recent years, economists and operation researchers have devoted considerable effort to the study of various dimensions of the health care delivery system and of the dynamics of health manpower supply and requirements. As such, a number of key aspects of economic theory--including the use of econometric models and concepts such as economics of scale, internal rate of return, and income and price elasticities--have become more prevalent in the health literature.

Concurrent with this development, and proceeding somewhat independently, has been a marked expansion in studies and articles concerned with specialty and geographic imbalances of health services and manpower. These developments apparently reflect a recognition that aggregate, national profiles of health dynamics provide only partial insights into understanding and groping with problems of equity and distribution.

Since its inception in 1970, the Division of Manpower Intelligence (DMI) of the Bureau of Health Resources Development has been vitally interested and actively engaged in analysis of both of these areas. As part of its extramural program, consequently, a number of major analytical efforts have been undertaken that attempt to examine empirically current and future dimensions of the health care delivery system and health manpower.

In line with these program objectives, in 1972 DMI commissioned the Division of Business and economic Research, College of Commerce and Industry, The University of Wyoming, to undertake a research effort concerning the use of economic theory in health locational decision-making. Specifically, the first part of this effort was to explore and determine whether the economic system could effectively be used as a surrogate in health planning for the health-care delivery system. The second aspect of this research endeavor was to estimate the interrelationships of the health manpower education system with the economic system and the health-care delivery system. The overall objectives of the project were to determine the applicability of regional economic theory in this framework, hopefully to lend further insights into the process of locational decision making, and to develop a useful tool and perspective for the health planner.

From the viewpoint of social science research, the results of this study effort represent important, initial steps in the empirical process. In this regard, a number of research areas are proposed within the study to further validate hypotheses presented and to test the transferability of the study results to other settings. From the viewpoint of practitioners of health manpower planning, at the same time, the study provides useful insights and perspectives. Challenge is given in the study, for example, to the traditional usage of practitioner/population ratios, while a rationale is provided for concentrating on communities and economic trade areas for planning purposes rather than using political-geographic jurisdictions.

This publication represents the final report of the contracted research. John M. Leyes, Ph.D., currently with the Virginia State Council of Higher Education, was the primary author and project director for this research effort. During the course of the actual research work and the preparation of the final report, Dr. Leyes was Assistant Professor of Economics at the University of Wyoming. Other authors on the staff of Dr. Leyes included J. Stuart Miller, Joyce Lofgre, Jeffrey White, and Sara Goetz. Paul M. Schwab, of the Division of Manpower Intelligence, BHRD, HRA, was project officer for this extramural activity.

Copies of a summary report of this study, entitled The Delineation of Economic and Health Service Area and the Location of Health Manpower Education Programs--A

Summary, can be obtained by directing requests to the Information Office, Bureau of Health Resources Development, Health Resources Administration, NIH, Bethesda, Maryland.

WALybrand

William A. Lybrand, Ph.D.
Director
Division of Manpower Intelligence

FOREWORD AND ACKNOWLEDGMENTS

The research reported herein pertains to the interrelationships of the economic system, the health-care delivery system, and the health manpower education system and was funded by a contract for the former Bureau of Health Manpower Education (now the Bureau of Health Resources Development), National Institutes of Health, Department of Health, Education, and Welfare, Contract No. NIH 72-4083.

In the past, research into the health-care delivery system has been focused on this system as a separate entity independent of the economic system. In fact, the provision of the set of health-care services to consumers is not fundamentally different than the provision of the set of economic services to consumers by other individuals. It would, therefore, seem reasonable to expect that detailed information about the economic system would be helpful in studying the health-care delivery system. Further, data on the health system are not collected regularly and uniformly, with the result that each study of the health system requires some survey work. If the economic system and the health system are closely related, and given the more complete data on the economic system, then the greater is the probability that the economic system can be used as a surrogate for the health-care delivery system. In this research, it was learned that in a part of the intermountain region predominately rural in nature, the two systems are closely related.

A second and important part of this research was the estimation of the interrelationships of the health manpower education system with the economic system and the health-care delivery system. The research results varied between inconclusive and fruitless. Part of the difficulty with the identification of the health manpower education system is the fact that schools of health manpower education tend to be located on the basis of political considerations rather than upon pure allocative considerations, and that there is a dearth of information on the students and places of employment after graduation. This is further compounded by the fact that there is virtually no meaningful information on the optimal size range of individual health manpower education programs. In view of the lack of fundamental information on the nature of health manpower education programs, the research must necessarily be speculative and subjective. Additional research into these target areas has the potential of greatly improving the present understanding of the health manpower education system. It is, therefore, strongly recommended that additional research be conducted in the following three areas before it will be possible to relate the economic system and health-care delivery system to the health manpower education system:

a. determination of the distances that students will travel for attending individual health manpower education programs;

b. determination of the distance that students will consider in accepting employment after graduation; and,

c. determination of the optimal size range for individual health manpower education programs.

It is the belief of the authors that research into the above topics is essential before it can be meaningful to suggest the optimal location of health manpower education programs by individual program.

The authors wish to express their appreciation to the many individuals in the seven-state region who provided most of the data used in this research. Without their and their staffs' generous contribution of time, this project could not have been completed. The authors would also like to express their thanks to Mr. Paul Schwab, Division of Manpower Intelligence, Bureau of Health Manpower Education, for his efforts to assist in the collection of data and his assistance in the determination of resource persons who could ease the research through its various difficulties. The staff of the Division of Business and Economic Research was immensely helpful in typing, editing, and other tedious and time-consuming details that make the completion of a report such as this possible. Finally, the authors would like to thank Ms. Keren Davis and Mr. Stuart Grinnell who provided the able and diligent handling of all of the computer programming and data processing tasks. To each of the above, the author is grateful.

John M. Leyes, Ph.D.
Project Director

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ABSTRACT

This abstract provides a brief review of the report on research conducted by the Division of Business and Economic Research, University of Wyoming, for the Department of Health, Education, and Welfare, National Institutes of Health, Contract No. NIH 72-4083.

The inadequacy of health care in rural areas of the United States is a problem: attempted solutions have ranged from specific federal grants for hospital construction under the Hill-Burton Act, to the establishment of Regional Medical Programs and Comprehensive Health Planning districts to assess the needs of rural areas and establish corrective policies. Recent developments include the formation of Area Health Education Centers and Health Maintenance Organizations.

In this study, preliminary attempts have been made to use the regional economist's central place theory to compare the economic system and the health care system of the intermountain region. The authors have suggested that this theory has potential if extended to health planning and health manpower planning, by using the economic system as a surrogate for the health care delivery system. This study provided a test for the efficacy and usefulness of central place theory as a potential policy formation tool for both health and health manpower planning.

The specific part of central place theory that has been applied in this study is that of hierarchical demand structures. The latter is based on the notion that the amount of and frequency with which consumers purchase goods and services varies according to the type of goods and services. Groceries are purchased more frequently than clothing, which is purchased

more frequently than hospital services, which, in turn, are purchased more frequently than nursing home services.

The purchase of these commodities will vary from community to community. Consumers will be willing to travel greater distances for automobiles than groceries, and greater distances for hospital services than for the services of primary care physicians. Because the range of commodities sold will vary from community to community, it is possible to infer, from the hierarchical structure of commodities, a corresponding hierarchical structure of communities, trade services and health service areas.

Seventy-four economic variables were identified and used to delineate a hierarchical economic system for a part of the intermountain region characterized by rurality and low population density. The same geographical region was also used to delineate the health care delivery system with twenty-four variables.

The two systems, economic and health care delivery, were delineated with a programming methodology that permitted the grouping of 538 communities into seven different groups, each composed of the most similar communities.

The above methodology was developed on the basis of individual communities rather than individual counties. The emphasis on communities seemed well-founded for a study of the intermountain region because the counties tend to be large and distances between individual communities is, therefore, frequently correspondingly large. Further, given the low population density, countless problems arose in finding data for both the economic and health systems at the sub-county level. Nevertheless, the data used are similar to the data used for studies in other regions (e.g., Minnesota and Saskatchewan) and yielded results that were consistent with the expectations of observers familiar with the intermountain region.

Notably, the emphasis of this study is not placed on the independence of counties, planning districts and other geographical regions. Further, it is fully recognized that a hierarchical system exists. The implications are rather simple. If, for example, the minimum population base (both indigenous and hinterland to a community) needed to support some economic activity is 100,000, then, a population of less than this amount would not be expected to have this kind of economic activity. Similarly, if a population base of 100,000 is required to support some health care activity, then a smaller population would be unable to support the activity. The next step was the identification of relationships between the economic and health care systems. If there is a close relationship between these systems, economic data can be used to identify the threshold levels for health care services. A threshold level is the minimum range of population base and economic services that must exist before some health care service will be provided.

In this study it was not possible to identify the interrelationships of the economic and health care systems. It was, however, possible to identify a very close relationship between the economic and health care systems using regression analysis. The encouraging nature of these results suggests very strongly to the authors that further research into the specific interrelationships should prove to be rewarding. The use of the economic system as a surrogate has two advantages: first, the data on the economic system are collected regularly by the federal government; and secondly, much of the economic data have been collected for many years, allowing trends to be observed, which cannot, for the most part, be observed for health manpower and health manpower education. If the economic system and data can be used as surrogates for the health system, then massive data collection efforts and data analysis for health manpower can be modified substantially by substituting data from the economic system.

The authors recognize that these ideas and this approach are inconsistent with the trends in current health manpower and health system research. Nevertheless, it is recommended that: (a) additional research be devoted to the study of an urban region to determine whether the similarity of the economic and health systems would hold for such a region; and (b) additional research be directed to determine the specific relationships between the economic and health care delivery systems.

Given the lack of data on health manpower education programs, it was not possible to test the hypothesis that the health manpower education system is functionally dependent on either the health care delivery system or the economic system. This was precluded by data problems. First, information is required on place of residence for students enrolling in programs. For some programs such as medical education, students may be willing to migrate a great distance. For other programs, students may not travel more than five or ten miles. In the absence of such information, it is difficult to estimate the optimal location of any health manpower education program.

Secondly, information on the optimal size range of each health manpower education program is needed. What is the minimum feasible size for such programs? And at what point does increased program size lead to increasing costs such that it would be cheaper to initiate a new program elsewhere? (That is, at what point do diseconomies of scale indicate a necessity of starting new programs rather than increasing present ones?)

With some definitive answers to the above points, it becomes feasible to consider optimal location. In the absence of this information, speculation is the only tool available to determine optimal location. The recommendation of this report is that research efforts be directed to find solutions to the above problems.

Although this study did not involve the estimation of health needs and the use of time-series data, the empirical results indicated that: (a) the methodology provided meaningful models of the economic and health systems in the intermountain region; and (b) the economic system data are easier to obtain than the health-care system data. Given the close relationship of the two systems, the economic system has the potential of being surrogate for the health-care delivery system.

A well-organized and informal health-care delivery system (neither physician nor hospital oriented) may exist in many small and rural places in the intermountain region. If such is the case, then rural and small community residents (1,000 persons and below) may be more receptive to primary health care by allied health manpower. This possibility should be explored with further research.

The major conclusions of this report are as follows:

a. statistically significant similarities exist between the hierarchical structures of the economic and health-care delivery systems;

b. it is recommended that hierarchical service areas be used rather than political units (i.e., counties and other popular area designations) for health planning;

c. it is possible to make inferences about health services which a community and its market area population can support by noting the number and types of business establishments located in the area;

d. the hierarchical nature of the economic system has the potential to serve as an efficient base for locating health manpower education programs; and,

e. the justification of new health manpower education facilities on the basis of existing facilities biases locational decisions against rural areas which generally do not have any supporting facilities.

CHAPTER I

INTRODUCTION

The inadequacy of health care in rural areas of the United States has been a problem. Attempted solutions have ranged from specific federal grants for hospital construction under the Hill-Burton Act to the establishment of Regional Medical Programs and Comprehensive Health Planning districts for the purpose of assessing the needs of rural areas and establishing policies which will best solve the problems. More recent suggestions are the formation of Area Health Education Centers and Health Maintenance Organizations. Due to the growing interest in improving the quality and quantity of health services, efficient planning techniques must be developed.

In this study preliminary attempts have been made to use the regional economist's concept of central place theory as a tool for health planning. Further, efforts have been made to use the economic system as a surrogate for the health system. Thus, this study provided a test for the efficacy and usefulness of central place theory as a policy formation tool for health planning.

In the remainder of this introductory chapter there is a description of the rationale for the study; an introduction to the conceptual basis of the methodology; and a listing and explanation of hypotheses to be tested.

A. RATIONALE FOR THE STUDY

Inadequate health care in rural areas is a product of several problems. The most debated problem is the deficiency in the number and distribution of physicians. But several other deficiencies exist which are also crucial in the provision of adequate health care. To better understand the difficulties, a review of the characteristics of the health-care system in rural areas of the United States follows.

That the number of doctors in rural areas (and urban ghettos) is less than desirable has been argued in many studies and public documents. President Nixon in his February 18, 1971, message to Congress on Comprehensive Health Planning, emphasized the problem:

> On the average, there is now one doctor for every 630 persons in America. But in over one-third of our counties the number of doctors per capita is less than one-third that high. In over 130 counties, comprising over eight percent of our area, there are no private doctors at all--and the number of such counties is growing. (Nixon, 1971).

Other symptoms of the rural health dilemma are: solo practices present few opportunities for consultation with other health professionals; there is the lack of modern sophisticated medical equipment for diagnosis and treatment, and the absence of medical specialties; and the rural community is relatively dependent upon "locked in" health manpower for long periods of time.

Although federal monies have been important in the creation and building of health-care facilities in the states (i.e., hospitals, medical schools), not all states have benefited equally. Facilities have been developed so that better health care would result; however, many rural areas have not had the same opportunities as the more densely populated areas of the country. Further, rural areas have found it difficult to attract health professionals and to retain those settling in these areas. And due to the lack of expensive health-care facilities, it has been more difficult for health professionals in rural areas to obtain training in current techniques. Consequently, rural health professionals tend to become more efficient at providing increasingly obsolete health care.

In attempting to alleviate the rural health-care problem, questions arise as to what types of health services, manpower facilities, and educational programs might be planned for rural areas and where they would best be located. It is the rationale of this study that efficient and effective planning for meeting health-care needs can be obtained by better understanding of the relationship between the existing economic and health delivery systems. The major hypothesis is that the provision of health services and the number, size, and types of health delivery facilities in an area will be determined by the general market forces that determine the number, size, and types of other non-health businesses and services within a region.

If the major hypothesis is correct, then the task proposed is choosing the theoretical model most appropriate for the allocation of health services and programs within a rural region.

B. PLAN OF THE STUDY

The types of economic areas delineated in the study are developed from the concept of hierarchical demand structures which is derived from a branch of regional economic analysis called central place theory. Hierarchical demand structures exist due to the amount and frequency that consumers purchase goods and services. For example, groceries are purchased by a consumer more frequently than clothing, which is purchased more frequently than automobiles. Moreover, the purchasing of each of these commodities is often done in different communities. While groceries are generally purchased from neighborhood supermarkets, clothing may be purchased in a more distant shopping center or in another community in the case of rural areas. The purchase of an automobile may involve a trip of some distance. By noting the kinds of goods and services sold in a community, it is possible to infer from the hierarchical nature of the goods sold a corresponding hierarchical structure of communities and trade service areas. This methodological approach is used in the delineation of economic areas.

The notion of a hierarchical structure is also applied to the health-care delivery system. While a physician may be consulted frequently, a consumer may not need the facilities of a hospital as often. In this study, health manpower and facilities data are used. The use of these data reflects the kinds of health services available in each community and allows a hierarchical ranking of communities according to health services offered.

After the economic and health structures have been determined, determination of the interdependencies of rural communities and larger cities for economic and health purposes is next. Analysis developing general relationships between the economic and health systems occurs for the purpose of identifying community economic characteristics existing concurrently with the levels of health services.

Finally, the number, type, and location of existing health education institutions are identified: the areas served by these institutions in terms of student enrollment are determined: and the dependency of the regional health manpower groups on local, state, regional, and national education and training institutions is analyzed.

The following hypotheses are tested in the study:

1. There are statistically significant similarities between the hierarchical structures of the economic and health-care delivery systems;
2. Hierarchical service areas are preferable to political units (e.g., counties) and other popular area designations as units for health planning;
3. Inferences can be made about health services which a community and its market area population can support by noting the number and types of business establishments located in the area;
4. The hierarchical nature of the economic system can serve as an efficient base for locating health manpower education programs.

There are nine chapters in this study report. In Chapters II through VI the methodology is derived, applied to the study region, and analyzed with respect to its effectiveness. Chapter II is a review of the literature of central place theory and empirical efforts toward applying that theory. Other popular derivations of economic areas relevant to this study are also analyzed in Chapter II.

Chapter III is an outline of the development of the empirical methodology employed in the study as well as a description and evaluation of the economic data utilized in the study.

In Chapters IV and V are results of the applications of the methodology to the economic and health-care delivery systems in the study region--the state of Wyoming and portions of adjacent states. Suggestions are made as to the extent the methodology can be utilized in deriving specific rules for health planning. Also, since one of the important and difficult tasks for the study was locating and collecting health data, a detailed description of health data sources is in Chapter VI.

In Chapter VI there is a brief statistical and verbal comparison of the economic and health delivery systems delineated in the previous two chapters.

A description and analysis of health manpower education for the study region and the relation to the hierarchical concept is the focus of Chapter VII. Implications for the establishment of health manpower education programs are presented.

Chapter VIII is a discussion of the planning and policy implications of the study. The results of the study are summarized in Chapter IX.

CHAPTER II

LITERATURE REVIEW

Health-care planning requires the delineation of planning areas--units reflecting the areal extent of health-care services. The most important factors in the determination of these units are the orientation of the analyst making the delineations and the planning purpose for which the areas are to be used.

A classification of bases for clarifying medical service areas has been devised: administrative bases, ecological bases, and optimization bases (Taliaferro, 1973). The use of the first of these categories, administrative bases, does not require data reflecting consumer use of health-care services, but involves the arbitrary choice of areas. The result is the selection of political boundaries (e.g., counties) as boundaries for health service areas. The basis of the category, ecological bases, is data on consumer-use patterns interpreted to determine the health service areas. Finally, the optimization bases category includes consumer-use data incorporated into a theoretical framework imposed by the analyst.

The data employed in the above methodologies reflect consumer use of medical services only. The thesis of this study is that service areas derived from economic data reflect medical service areas and allow health planners to forecast the demand for health services and to estimate the types of health manpower and health manpower education facilities on the basis of observable economic activities. If the thesis is correct, the administrator will be able to make a variety of recommendations without undertaking expensive consumer surveys or studies of hospital records. Therefore, the literature review in this chapter is a survey of methods for the delineation of economic areas.

The traditional categorizations of economic areas are homogeneous regions and functional regions. In the formulation of homogeneous regions, spatial units (e.g., communities, consumers) are of the same region on the basis of similarity with respect to some attribute or set of attributes. In the organization of functional regions, spatial units are linked as to their interdependence or interaction (Harris, 1964; Nourse, 1968, pp. 129-36). These interdependencies are demonstrated in terms of flow phenomena: labor force commuting, circulation of goods and services, telephone communications, and traffic flow. Health service areas delineated according to consumer residence and hospital use are examples of functional regions.

The areas discussed in this study are functional regions developed through an analysis in regional science called central place theory. While homogeneous regions serve specific purposes, the view among regional scientists is that functional areas are optimal for planning purposes (Richardson, 1969, pp. 226-30). The major effort of delineation of generalized homogeneous areas for the United States (Bogue, 1961) has received substantial criticism concerning the methodology employed and the unserviceability of the results (Richardson, 1969, pp. 225-27; Vining, 1953; Fox, 1965a, p. 4).

In the remainder of this chapter there is, first, a description of central place theory, the basis for the functional areas developed in Chapters III and IV; and, second, a review of the methodologies traditionally employed in empirical studies applying central place theory.

A. CENTRAL PLACE THEORY

1. The Concept of a Central Place

The concern with a town as a central place relates to "city-forming" activities of which there are three classes (Harris, 1942; Marshall, 1969, Chapter I). First, towns are transportation nodes situated to facilitate transshipment, maintenance, and other necessary transportation services. Second, towns perform functions connected with resources and intermediate production activities, and are located in accordance with activities such as mining, manufacturing, wholesaling, and seasonal resorts. Third, towns supply consumption goods and services directly to the surrounding consumer population and are located to ease the transportation friction (time and cost) of consumers.

Harris and Ullman (1945) argue that each of these three city-forming activities operating alone would cause different patterns of spatial distribution of towns: a linear arrangement of towns would result from a linear transportation network; an uneven distribution of towns would result from resource connected activities that are unevenly distributed; and a uniform distribution of towns would result from the supplying of personal consumption goods and services if there is a uniformly distributed rural population to be served (Harris, 1945). However, the actual spatial pattern is a result of a combination of all three city-forming activities.

The concerns of formal central place theory are the spatial pattern of community locations with respect to retail markets and the "centrality" of a community, or the degree to which it is a central place.

2. Central Place Theory and Systems of Central Place

Central place theory relates the spatial results of supply and demand decisions. That is, when a commodity is presented for sale, a consumer's buying decision involves his consideration of the price, quality, and his transportation costs. Cost to the consumer increases with distance travelled. Since the amount demanded decreases as cost to the consumer rises, then the amount demanded decreases as distance from the seller increases. At some distance, quantity demanded from a seller is zero. This maximum distance establishes the maximum possible market area for the seller of the commodity. For the seller to continue in business he must have enough customers to make a minimum (or normal) profit. The area encompassing the minimum number of customers establishes the smallest market area for the commodity.

In the remainder of this section there is a description of the concepts of central place theory: first, the early formal statements of central place theory are reviewed; and second, consideration is given to more recent alterations in the theory which have made central place theory an empirically useful framework.

Christaller and Losch

The concept of formal central place theory has been attributed to two German scholars--Walter Christaller, a geographer, and August Losch, an economist--whose original works were published in 1933 and 1941, respectively (Christaller, 1966; Losch, 1954).[1]

The spatial economic model developed by Losch and Christaller contains strict assumptions. First, there are uniformity assumptions: raw materials and population are uniformly distributed over a homogeneous plain; tastes and preferences are similar for all consumers; transportation possibilities are equal in all directions; costs of production are constant; and production opportunities are open to everyone. The second set of assumptions are behavioral; producers attempt to locate for the purpose of maximizing profits, and consumers attempt to maximize satisfaction, which includes the minimization of purchase costs. Thus, consumers purchase goods and services from those sellers in closest proximity to their residences.

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[1] Generalized descriptions of the Christaller-Losch model can be found in many works. See, for example, Richardson, 1969, pp. 105-8, 156-65; Berry, 1967c, Chapter 2; Nourse, 1968, Chapter 3; Marshall, 1969, Chapter 2.

Given these uniformity and behavioral assumptions, sellers of a commodity locate such that they are equidistant from one another over the homogeneous plain. Each, therefore, sells the product over the minimum sized market area possible and earns normal profits. If the market areas of sellers are to cover the plain leaving no gaps, each area has the shape of a hexagon. Recalling that transportation is equally possible in all directions and postulating that there is no overlap of markets, the hexagon is the geometric figure minimizing the distance (and travel cost for consumers) from each seller to the periphery of his market.

Using this framework, there are as many market networks as goods and services. Individual sellers have a hexagonal market area the size of which is determined by the class of commodity sold: a small area for lower order, convenience items as groceries, retail gasoline, laundries; and a larger area for higher-order, specialized goods as sporting goods and furniture (for which consumers will travel greater distances). Moreover, sellers of different goods locate at the same center to minimize the frequency of trips and, therefore, transportation costs of the consumer. A hierarchy of central places over the plain results. Lower-order places offer a number of convenience goods, and higher-order places offer specialized goods in addition to convenience goods.

In summary, the conclusions of the Christaller-Losch theory are the following:

1. the centrality of a place is determined by the number of types of commodities sold. Central places offering higher-order, specialized goods have greater centrality than those offering lower-order goods.

2. higher-order central places have larger complementary areas (market areas) than lower-order central places.

3. market areas are hexagon-shaped. Lower-order places and their areas "nest" within the areas of higher-order places.

4. hierarchical groups of central places are determined with central places in each group performing all functions of places in lower groups plus additional functions.

5. establishments performing lower-order functions or selling lower-order goods are more numerous than establishments performing higher-order functions.

Recent Alternations in the Theory

Reasons exist that the above model does not depict reality. Transportation costs are not uniform in all directions and are strongly determined by the nature of transportation networks. Raw materials are not equally distributed, nor is the topography of an area a homogeneous plain. Also, population is not uniformly distributed or similar in tastes, preferences, and incomes. Finally, technological change in transportation and production methods as well as alterations in production costs due to agglomeration economies alter the shapes and sizes of market areas and their centers.

As a result, alternations are made on the Christaller-Losch model.

A contribution to the generalization of the concepts of the original central place model is a 1958 paper by Berry and Garrison (Berry, 1958) stating that the concepts necessary for the formulation of a hierarchical spatial structure of central places are range and threshold. The range is the market area of the central place for a commodity and is determined by transportation costs (but is influenced over a period of time by techological improvements). Threshold refers to the lower limit of the range of the commodity necessary for it to be supplied at a normal profit.

Assuming that sellers locate to maximize profits, the conclusions reached using the range and threshold concepts are: (1) markets contain equal amounts of purchasing power; (2) markets for central places of the same order need not cover equal-sized areas, and centers need not be equidistant from one another; and (3) sellers may not earn only normal profits but excess profits (see Marshall, 1969, pp. 33-7).

A hierarchical structure of central places is derived from this formulation. Firms selling the highest order commodity (having largest threshold size--commodity n) locate to maximize profits. There are as many centers for commodity n as threshold level sales to support firms selling commodity n. Firms selling lower-order goods and services (n-1, n-2, etc.) also locate in centers selling commodity n. Since market threshold levels decrease for lower-order commodities, firms selling these goods and services earn greater than normal profits. For some commodity, n-i, the threshold is small enough that new firms locating in the interstices between threshold areas for existing firms and selling that commodity can make a normal profit. Firms selling commodities 1, 2,..., n-i, locate in these interstices forming a new, lower-order of centers: the highest order centers sell goods and services 1, 2,...n; and the next order centers sell commodity 1,..., n-i. An additional set of lower-order centers forms when threshold levels for a still lower-order commodity, n-i-j, allow interstitial location of new firms. A complete hierarchical system of central places is formed in this manner, the number of groups of central places being determined by the number of possible interstitial locations.

This general system is suitable for empirical measurement of real world central place hierarchies because none of the uniformity assumptions of the Christaller-Losch model are necessary, and there is no restriction on the sizes and shapes of market areas.

B. EMPIRICAL STUDIES

Empirical determination of central place systems requires a two stage process--first, the placement of central places in the study area into a hierarchical classification and, second, the determination of hinterlands of the central places. As stated in the above section, determination of a hierarchy of central places is made by analyzing the types of goods and services sold in each. A number of studies have used this conceptual basis for forming hierarchical systems. In this section there is a review of the specific techniques employed in empirical studies to form the central place hierarchy, and of the methods followed to determine areas of influence or hinterlands.

The traditional approaches to empirical formulation of central place hierarchies utilize data listing for each central place the numbers of retail establishments classified according to central place function (e.g., gasoline stations, restaurants, grocery stores, banks, etc.). To obtain data on specific goods and services is more difficult than to count establishments by retail classification. However, there are two deficiencies in the data obtained by counting establishments by retail classification. First, there is difficulty in classifying establishments selling multiple goods and, second, no distinction is made between establishments in the same classification which vary in floor space size and in sales volume. Therefore, such additional data as volume of retail sales for each community, the population of each community, and the relative geographic isolation of the community in relation to other communities are considered.

The construction of maps indicating the hinterlands of central places often results in the utilization of political boundaries, county or state lines. A contention of this study is that the equating of political boundaries with economic boundaries is an incorrect procedure. Economic areas seldom follow political boundaries (see Chapter IV).

Given the above summary of approaches, the method for surveying techniques of specific studies is to review the procedures followed in well-known areas: Trade Areas published annually by Rand McNally in the Commercial Atlas and Marketing Guide (Rand McNally, 1972); the Office of the Bureau of Economic Analysis (BEA) Economic Areas published by the Commerce Department; and Functional Economic Areas (FEA's), originally suggested by Fox (Fox, 1965b) and recently supported in a United States Bureau of the Census Working Paper (United States Bureau of the Census, 1969). Other studies in the regional science literature are summarized. The focus of the study is analysis of rural regions, therefore, the emphasis of the review is the application of the methods to rural areas.

1. Ranally Trade Centers and Basic Trading Areas

Rand McNally publishes annually maps denoting trade centers and areas. Available at many libraries, they are a source for determining planning areas.

In 1972, 1,615 cities in the United States received Ranally ratings, therefore, most rural communities were not rated. More types of data have been available from secondary sources for cities than for small rural communities. Examples of data from secondary sources are retail sales, sales of shopping-goods, daily newspaper circulation, wholesale activity, volume of banking activity, and the number of competing banks (Rand McNally, 1972, p. 5).[2]

The manner in which these items are interpreted is not indicated clearly in the _Commercial Atlas_. A telephone conversation with Mr. Richard L. Forstall, Editor of the _Commercial Atlas_, has yielded a description of the rules used. Factors most weighted are shopping-goods' sales and daily newspaper data (total circulation and competition over the area of influence). Each of these factors receives about 40% of the total weight in determining whether a city is rated and the rating given. The remaining 20% of the rating decision is a combination of items: number of banks, retail sales, and location of the city in relation to other cities. The result is four groups of cities rated hierarchically. Within each group there are as many as four sub-categories.

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[2] Shopping-goods are defined by Rand McNally as "... retail items that the shopper ordinarily travels some distance to purchase, and for which he or she frequently compares qualities, styles, and prices from store to store before purchasing. The general merchandise and apparel categories represent the shopping-goods group quite closely." (Rand McNally, 1972, p. 8).

The formation of Basic Trading Areas is explained as follows:

> Basic Trading Area boundaries are drawn so as to include with each Basic Trading Center the county or counties whose residents make the bulk of their shopping-goods purchases in that center. (Rand McNally, 1972, p. 8)

Mr. Forstall further commented that the primary consideration is the area of circulation of daily newspapers. In 80-85% of the counties, newspaper circulation allows assignment to a trading area. The prevailing hypothesis is that consumers shop in those centers from which they receive daily newspapers. In the remaining cases--where the assigning of a county may be possible to either of two centers (e.g., the eastern half of the county is influenced by a city to the East, but the western half is influenced by a city to the West), then the assignment becomes more arbitrary.

There are reasons why the methodology employed in identifying Ranally Trade Centers and Trading Areas is deficient, particularly for application in rural regions:

1. in remote rural areas (e.g., Wyoming), some cities are termed trading centers due to their isolation from other centers.

2. the criteria by which cities are assigned to a particular group in the hierarchical rating structure are not clear. For example, cities with rating four are described as follows: "Most 4's have a daily newspaper with 5,000 or more circulation, as well as three competing banks and $3 to $4 million in annual shopping-goods sales" (Rand McNally, 1972, p. 5). This description is not precise.

3. most communities in rural areas are not classified since they are small, and the data needed for classification are not available.

4. the areal units used in determining trading areas are counties.

There is no reasoning presented to substantiate the employment of county boundaries as economic boundaries. Moreover, the use of counties as areal units assigned to nodal centers implies that counties are economic units as well as political units. This conclusion requires substantiation by empirical analysis, but none appears in the Rand McNally Atlas.

5. Mr. Forstall indicated that the current map has not been changed since 1960.

2. Bureau of Economic Analysis Economic Areas

In the late 1960's, the Office of Business Economics in the United States Department of Commerce constructed economic areas for the purpose of "... regional measurement, analysis and projection" (United States Department of Commerce, 1967). Originally called OBE Economic Areas, they have recently been designated BEA Economic Areas. They are of interest because the theoretical basis for the areas is central place theory.

The economic or nodal centers with which the BEA areas have been concerned are Standard Metropolitan Statistical Areas (SMSA's) designated by the Census Bureau. In rural areas where there are no SMSA's, cities with 25,000 to 50,000 population have been chosen as centers.

The delineation of economic areas surrounding the centers was accomplished by assigning counties to centers on the basis of journey-to-work commuting data from the 1960 Census of Population. Counties were assigned to the economic area containing the center with which there was the greatest commuting connection. In cases where commuting data showed no connection with an economic center, the county in question was placed in an area on the basis of commuting connections to counties which had already been assigned to areas.

> Thus, for the first ring of counties around the central county, the criterion was commuting to the latter while for the next ring the criterion was commuting to the central county or to the first ring. (United States Department of Commerce, 1967).

Rural regions of the country presented a problem in the delineation of BEA areas because of the scarcity of daily commuting across county lines.

> For those areas the road network and certain geographic features which would affect the possibility and time of travel to the economic centers, and the linkage of counties by other socioeconomic ties such as communications and cultural, recreational and trade activities were the major determinants. (United States Department of Commerce, 1972).

A critique of the methodology used in determining BEA Economic Areas would indicate the following deficiencies:

1. the notion of a hierarchy of centers was not incorporated. The largest of SMSA's received equal rating with rural communities of 25,000 population. The hierarchical structure has been a key concept in central place theory.

2. centers were designated only on the basis of population. Economic activity was of no consideration in the choices.

3. county boundaries were employed as boundaries to the economic areas, and counties were treated as if they were economic units. The criticisms of this procedure were discussed above with respect to Rand McNally Trade Areas.

4. the use of commuting data had to be abandoned in rural areas in favor of generalized observations, thus adding inconsistency to the methodology.

3. Functional Economic Areas

K. Fox has argued that for planning purposes, self-contained economic communities make theoretical and administrative sense. According to Fox, these communities, Functional Economic Areas or FEA's (Fox, 1965b), would:

> ...be large enough to contain a full range of shopping facilities, personal and professional services and recreational facilities... and their residents would be ...linked together through a multitude of relationships--customer and retailer, patient and doctor, client and lawyer, pupil and teacher, parent and school board member, employer and employee--so that the great majority of their face-to-face dealings were with residents of the same sub-area. (Fox, 1965a).

The boundaries of FEA's could be determined by home-to-work commuter fields which have grown larger with improvements in transportation.

A recent Working Paper for the Census Bureau suggested constructing FEA's by the use of census data which classify and tabulate work places for workers by census tract (United States Bureau of the Census, 1969). The general suggestions for proceeding empirically were: (1) use of commuting data to find commuting contours (i.e., percent of resident census tract labor force commuting to the center) enclosing the central areas; (2) use of a gravity model to allocate those counties unallocated by the above step[3]; or (3) use of a "cascading" method to assign unallocated counties. Cascading involves consideration of commuting not only to the center but to all counties already assigned to the FEA.[4] If overlapping of areas occurred, then the overlap was allocated to dominant areas by the definition of dominance used in the particular study.

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[3] Gravity models hypothesize that a city attracts outside consumers in direct proportion to the size of the city and in inverse proportion to the distance of the consumer's residence from the city. To assign counties in the case being discussed here, a gravity formula is applied to the county and central cities to which it might be assigned. The city with the resulting highest value in the formula is assigned the county (see Carrothers, 1956; Reilly, 1931; Schwartz, 1963; Converse, 1946; Isard, 1960).

[4] This "cascading" procedure conforms precisely to the method used in forming BEA areas. See Section 2.

Attempts to apply empirically the FEA concept are recent. Consequently, the specific means of application to rural regions is not always clear or else requires some independent judgments by the analyst. Fox has suggested that the cornerstone of the FEA concept as a planning unit is the regional capital having 25,000 to 250,000 population which generally has a trade area coinciding with its commuting field (Fox, 1969). However, he has indicated that in some rural areas the cities serving as central cities may be smaller (Fox, 1965a). The choice (utilizing economic and population growth) as well as the determination of the formula used is the task of the analyst.

A second vagueness arising with respect to the FEA concept and its empirical application is the notion of the commuter. In rural areas where commuter data show very minimal commuting, Fox has stated that the commuting field is indicated by a boundary showing the normal distance representing one hour of travel time from the central city (Fox, 1965a, pp. 5-6).

Thus, while the FEA concept is an aid in understanding the significance of regional capitals and growing cities, it does not give a direction in either the choice of central cities or in the delineation of trade area boundaries. The Working Paper approach, though utilizing Fox's concept, deviates from his method in its suggested procedure of the inclusion of cascading and gravity models.

Listed below are weaknesses of the FEA concept as a planning tool in sparsely populated rural areas:

1. The use of commuter data has been criticized previously in this chapter, and the same criticisms apply.

2. Fox's applications of the FEA notion have left gaps in the region--

places not assigned to any FEA (Fox, 1965a)--but he has indicated that a system of FEA's with no gaps would be possible (Fox, 1965a, p. 12: Fox, 1969). However, specific procedure was not provided.

3. The Census Working Paper procedures involve allocation of county units, the objections to which have been stated previously.

4. The hierarchical concept of central places and their trade areas has been given minimal importance in the FEA concept in favor of the growth center or regional capital and its commuting fields.

4. Other Studies

In this review of empirical efforts to delineate economic areas the three most popular methods--OBE Areas, Rand McNally Trade Areas, and Functional Economic Areas have been described. Other empirical efforts exist; a few are discussed next.

One criticism levied against the above three techniques is vagueness in procedures for choosing central cities or for forming the hierarchical structure of cities. These vague and arbitrary procedures appear in other studies, examples of which are those by J. Brush of Wisconsin (1953), A. Smailes of England (1944), A. Baker and Associates of Missouri (1968), J. Borchert and R. Adams of Upper Midwestern U.S. (1963), and R. Preston of the Pacific Northwest (1971).

The first three of the studies mentioned (Brush, Smailes, Baker) are similar in that a hierarchical classification of communities has been described using as data the types of retail establishments and goods and services offered in the communities. In none of these studies, however, has an explanation been given of how the hierarchical orders were chosen or why the particular goods and services listed were important.

The Borchert and Adams study employed data on retail businesses and selected services combined into fifty-two groups of functions. The number of these functions and population were tabulated for each in a sample of 311 places. A majority of functions were found to occur in places of certain population size which were then used in defining classes of retail centers. However, the method of choosing breaking points between classes was not explained, and deviation from the technique of classifying by functions appeared. Some places were classified using either the number of functions or the minimum volume of retail sales (Borchert, 1963, p. 38).

The construction of trade area boundaries by Borchert and Adams was arbitrary and imprecise:

> The shopping trade areas have been defined by lines drawn at highway half-distances between complete shopping centers, then adjusting for barriers, such as mountain ranges, and differences in sizes of competing centers. (Borchert, 1963, p. 5).

Moreover, all trade area boundaries were constructed to coincide with political boundaries, a procedure previously questioned in this literature review.

R. Preston employed a concept known as functional surplus as the procedure for classifying the hierarchical classes of central places in the Pacific Northwest (Preston, 1971; Johnson, 1964 and 1971). That is, central places serve their internal population and service area plus the area adjoining--the external service area. The degree of centrality is related to the provision of goods and services in excess of the demands of inhabitants of the center. The empirical procedure involves measuring total demand (internal plus external area) for the goods and services of a center and subtracting the portion of the total demand represented by the center's internal residents.

Preston employed total retail sales and selected service sales in calculating total demand at centers; and calculated central place internal demand using data on numbers of families, median family income, and average percent of median income spent on selected goods and services. Centrality was considered surplus (total demand minus internal demand) dollar volume of sales. The advantage of this method, Preston has argued, is that all settlements are not automatically central places. Furthermore,

> ...it would appear that this seemingly elementary, but fundamental, finding would be impossible to establish when central place importance is determined by such nodality indexes as total population, retail sales, retail employees, key functions, or numbers of establishments or functions. (Preston, 1971, p. 140).

To order groups of centers, Preston used a moving average technique similar to that employed in measuring trends in time series analysis. The cumulative averaging and graphing of differences between successively larger centrality values for each of the central places allowed him to choose a five-order hierarchy based on changes in the slope of the cumulative average.

While the concept of functional surplus is interesting, its empirical application involves the use of unavailable data. Preston's calculation of internal demand, that resident purchases of the goods and services were made completely within their own communities, is an unsupported empirical assumption. Moreover, why has Preston utilized the moving average technique for determining classes? Also, why were five classes chosen?

To identify hinterlands for various classes of centers, Preston employed data on banking relationships, daily newspaper circulation, commuting patterns, Sunday newspaper circulation, and branch-firm distribution. Banking linkages between communities were used to identify complementary regions of the lowest (fifth) order central places. A map of daily newspaper circulation was superimposed on a map of commuting patterns (from census data) to determine areas for the next highest (fourth) order with the requirement that the fifth order regions fit within these. A map of Sunday newspaper circulation determined hinterlands for third and higher-order places. The areas for second and first-order central places were determined by the location of branch-firms whose home offices were located in these places. The use of these types of data for purposes of showing interaction is justified as long as the data used reflect the interaction occurring between the levels of central places.

The argument involving the use of newspaper data, as Preston has employed, is presented in Chapter III.

SUMMARY

The review in this chapter has presented an overview of methodologies used in applying central place theory. The criticisms of procedures used have consistently emphasized: (1) the arbitrary manner by which classifications of central places were made and identified; (2) the use of political boundaries as boundaries for economic areas; (3) the failure to utilize standardized procedures: and (4) the employment of data yielding inadequate information in sparsely populated rural regions (e.g., commuter data). The objective of Chapter III is to present in detail the methodology used in this study and the ways in which weaknesses of earlier studies have been avoided.

CHAPTER III

METHODOLOGY AND DATA

The problem of hierarchically classifying central places has been submitted to computer analysis. These efforts have made the handling of voluminous amounts of data involved in a study region of any size a feasible process. This study did involve large volumes of data and, consequently, the computer was employed in several of the steps.

As much as possible, efforts were made to collect data for 1970, nevertheless, data collection efforts were not restricted to 1970. Data sources were considered that ranged from 1965 to 1973. Further, a wide range of data sources was consulted, but was not included in the bibliography at the end of this report--the reason being that the data were too informal and dissimilar to be used in the context of a regional analysis.

A principal limitation of the secondary data sources was that virtually all of the sources provide data by counties. Since the counties in the intermountain region are quite large, county data were not particularly useful for identifying a system of cities, towns, and hamlets. Also, the nondisclosure policies of the Bureau of the Census meant that most data are not published for communities with a population below 5,000. Thus, the task of acquiring data for a rural region proved to be more difficult and time-consuming than was expected. Regions with high population densities are easier to study since many of the above problems are not important (i.e., large counties and nondisclosure policies).

The process of identifying the hierarchy of communities involved the following steps, each of which will be discussed in this chapter:

A. identifying the region to be studied;

B. identifying the pertinent economic activities;

C. identifying the health data and their sources;

D. formulating the quantitative techniques to be employed in classifying of places;

E. formulating the techniques to be employed in delineating service areas for the places.

A. IDENTIFYING THE REGION

The relationships between rural communities and their service areas (both economic and health) and between rural communities and urban cities are the focal points of this study. Consequently, the State of Wyoming was chosen as the study area. Characterized as a rural area, Wyoming's two largest cities have less than 50,000 population with essentially no suburban growth. A further consideration, however, prompted the expansion of the study area to include parts of the surrounding states. Because the subject to be studied was economic and health service purchases of Wyoming residents, those counties immediately adjacent to Wyoming were included plus those additional counties in the surrounding states that contain major central places (i.e., Denver, Colorado; Billings, Montana; Salt Lake City, Utah; Provo, Utah; Idaho Falls, Idaho; and Rapid City, South Dakota). A map of the region is provided as Figure III-1.

The choice of places in the study region to receive analytical consideration was based upon the location of post offices in the year 1971.

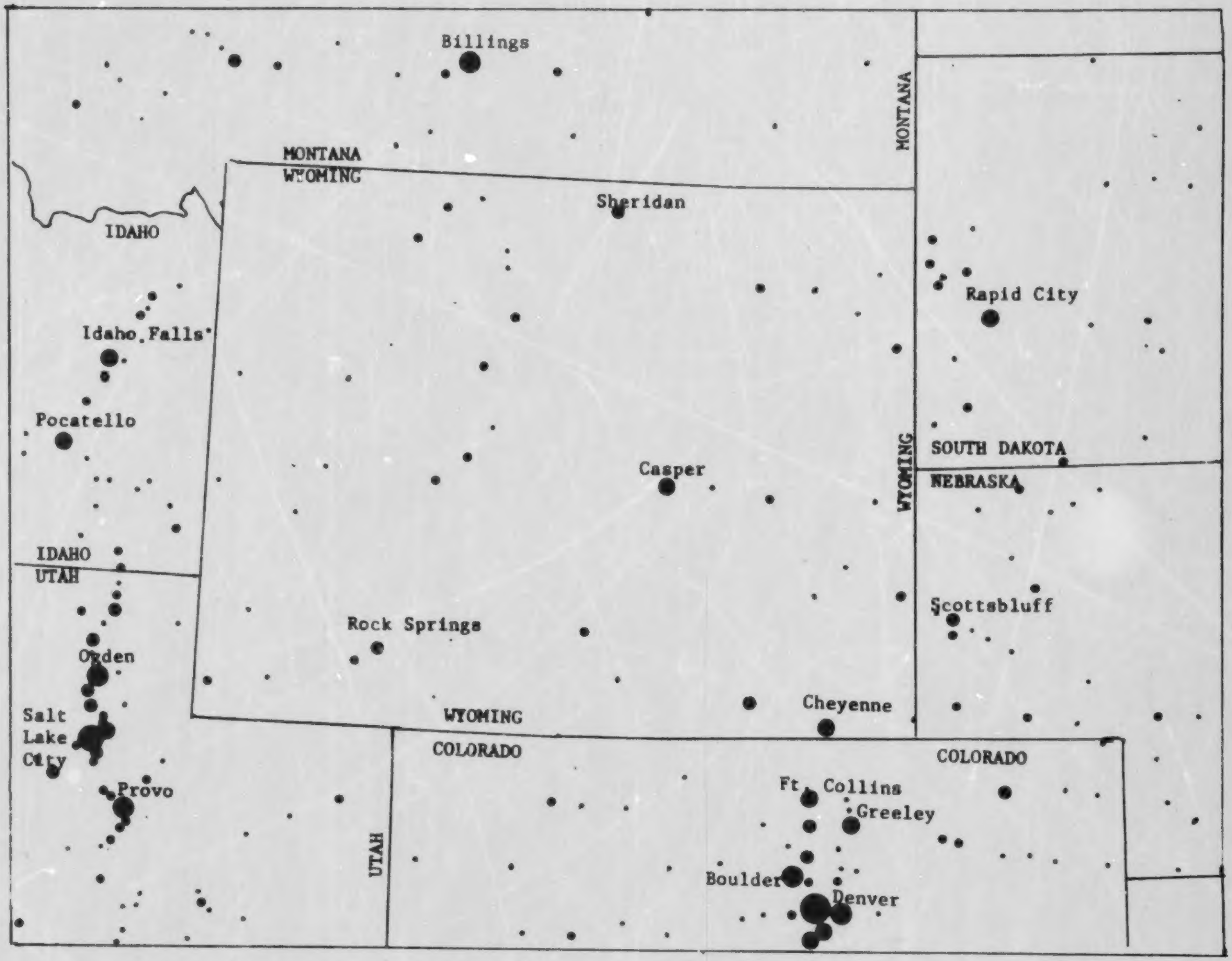
Billings
MONTANA
WYOMING
IDAHO
Sheridan
MONTANA
Rapid City
Idaho Falls
Pocatello
Casper
SOUTH DAKOTA
NEBRASKA
WYOMING
IDAHO
UTAH
Scottsbluff
Rock Springs
Ogden
Salt Lake City
WYOMING
COLORADO
Cheyenne
COLORADO
Provo
Ft. Collins
Greeley
UTAH
Boulder
Denver

FIGURE III-1

MAP OF INTERMOUNTAIN STUDY REGION

Post office locations containing one or more economic service activities (i.e., retail activity) became economic places in the study region. No place of any significance has been neglected since places where economic activities exist generally also contain a post office. Thus, 538 economic places were identified and included. An additional ninety-three locations had post offices but no other economic activity and were, therefore, excluded.

B. THE CHOICE AND SOURCES OF ECONOMIC VARIABLES

Goods and services are consumed in a range from convenience goods purchased frequently to highly specialized goods purchased infrequently. This concept was discussed in the review of central place theory in Chapter II. Consequently, the next step in the study involved the choice of a wide spectrum of variables reflecting all levels of retail economic activity.

An initial difficulty in the choice of variables was the location of data sources. The censuses (i.e., Census of Retail Trade, Census of Selected Services) did not provide data for places with small populations. The only alternatives providing enough descriptive detail to classify businesses by four-digit SIC codes were the Dun and Bradstreet Reference Book (Dun and Bradstreet, 1972) and the Yellow Pages of telephone books in the study region. These data represented business establishments (not commodities) and are similar to the studies of Borchert (1963), Hodge (1965), Philbrick (1957), and Preston (1971). This deviation from the theoretical foundation was unavoidable. However, this deviation should not alter confidence in the results of the study. A central place hierarchical system is based upon the notion that increasingly specialized goods and services are offered by a place as its rank in the hierarchy increases. This is represented as well by the specialization of establishments as by the specialization of commodities.

The 114 variables first chosen included: most SIC four-digit retail functions; wholesale activities; postal receipts; population by place; commercial air freight; and government services such as highways, state capitols, county seats, and junior and senior colleges. The seventy-four variables finally employed in the analysis are listed in Appendix A, with the data source for each. The process of reduction from 114 variables to seventy-four is described in Section D of this chapter.

1. Data Reliability

The data on retail and wholesale establishments were recorded from the 1972 Dun and Bradstreet Reference Book. A list of the types of establishments and the number existing in each place for 1971 was provided. Each of the codes was checked against listings in the Yellow Pages of telephone directories to determine the consistency and reliability of the Dun and Bradstreet data.

The Reference Book data were deficient in that, first, a number of businesses had not been referred to Dun and Bradstreet for credit checks; and second, this missing percentage of businesses varied from place to place. The quality of the functional data was improved by the Yellow Pages information. Further improvement would have been gained by a lengthy and expensive field survey of the study region.

Highway data were obtained from current state highway maps and were coded as follows: a 3 was assigned for each interstate highway passing through the place; a 2 was assigned for any other highway through the place; and a 1 was assigned for each highway leading to the town but not through it. These numbers were then added to obtain an index of highway accessibility for each place.

Data on postal receipts (United States Postal Service, 1971), commercial air freight (United States Department of Transportation, 1970), county seat (Rand McNally, 1972), and population (Rand McNally, 1972) were obtained from secondary sources subject to the sampling, estimating, and record deficiencies of United States Government agencies and Rand McNally.

2. Population as a Variable

An argument exists that the population of a place is a surrogate for the economic system since the number and areal influence of economic activities increase in some functional way with population. However, there is a major restriction on the use of population as a surrogate for economic activity, especially in the region under study. For any linear movement from a regional trade center, for example A in Figure III-2, there is a decline in population that is interrupted by the existence of sub-regional and other centers of economic activity, and these intervening centers serve the residents in their immediate hinterlands. Thus, most central places, from the regional center to small rural communities, serve a population greater than the population within the community boundaries. In this study a constant ratio between internal and external population cannot occur. In parts of the region communities, for example X in

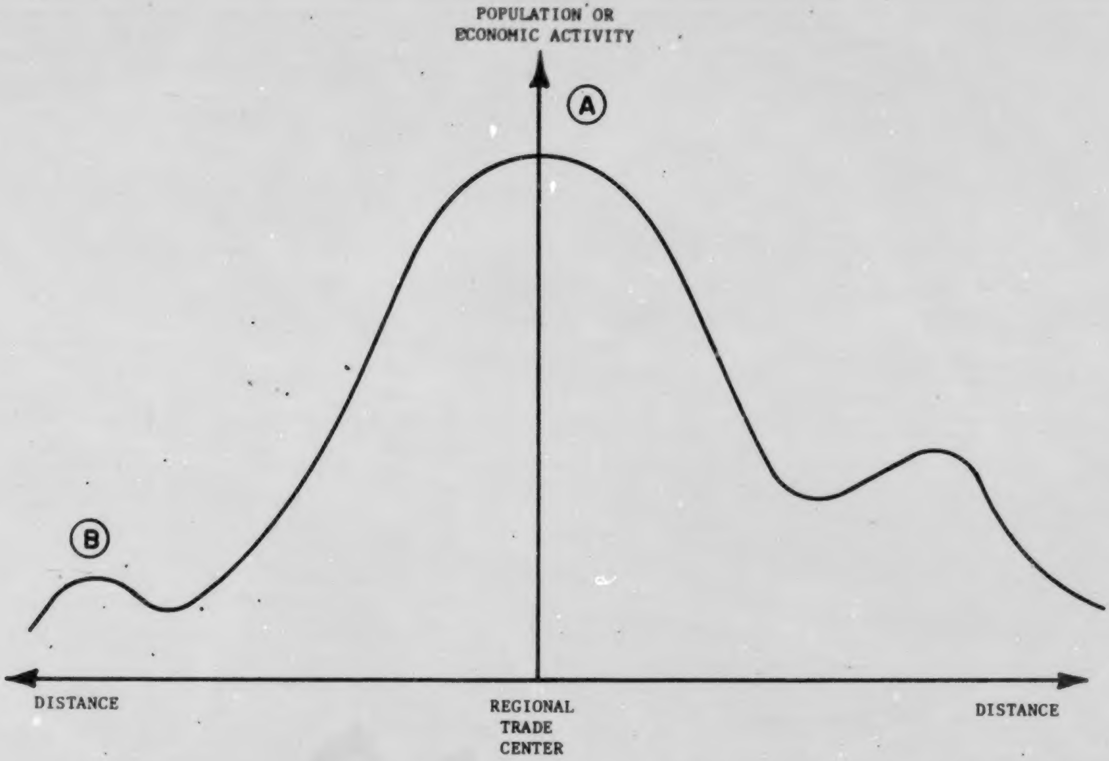
POPULATION OR
ECONOMIC ACTIVITY
A
B
DISTANCE
REGIONAL
TRADE
CENTER
DISTANCE

FIGURE III-2

EXPECTED POPULATION DISTRIBUTION AS LINEAR MOVEMENT OCCURS AWAY FROM A REGIONAL TRADE CENTER

Figure III-3, are islands of population and do not serve a hinterland population. Assuming that the population within the legal boundaries of B in Figure III-2 is equal to the population within the legal boundaries of X in Figure III-3, then the number and extent of economic activities in B will exceed the number and extent of economic activities in X. An example is provided in Section A of Table III-1.

The above relationship between internal and external population can be viewed in a second way--from the perspective of two communities with similar levels of economic activity, but different populations within the legal boundaries of the two communities. An example is provided in Section B of Table III-1. Three cases are presented where the population in two places is different, but where the levels of economic activity are almost equal.

Thirdly, the level of economic activity for communities of similar size varies with their respective distances from a larger trade center. The example of Billings, Montana; and Boulder, Colorado; is included in Section C of Table III-1. The proximity of Denver substantially decreases the amount of economic activity in Boulder.

C. THE CHOICE AND SOURCES OF HEALTH DATA[5]

The goal of health data collection was to include all health professionals, allied health personnel, and health service facilities. The list of twenty-three health variables subjected to analysis is included in Appendix B.

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[5] Since a detailed description of the health data and its wide range of sources appears in Chapter V of the study, the numerous bibliographical references have been omitted from this section.

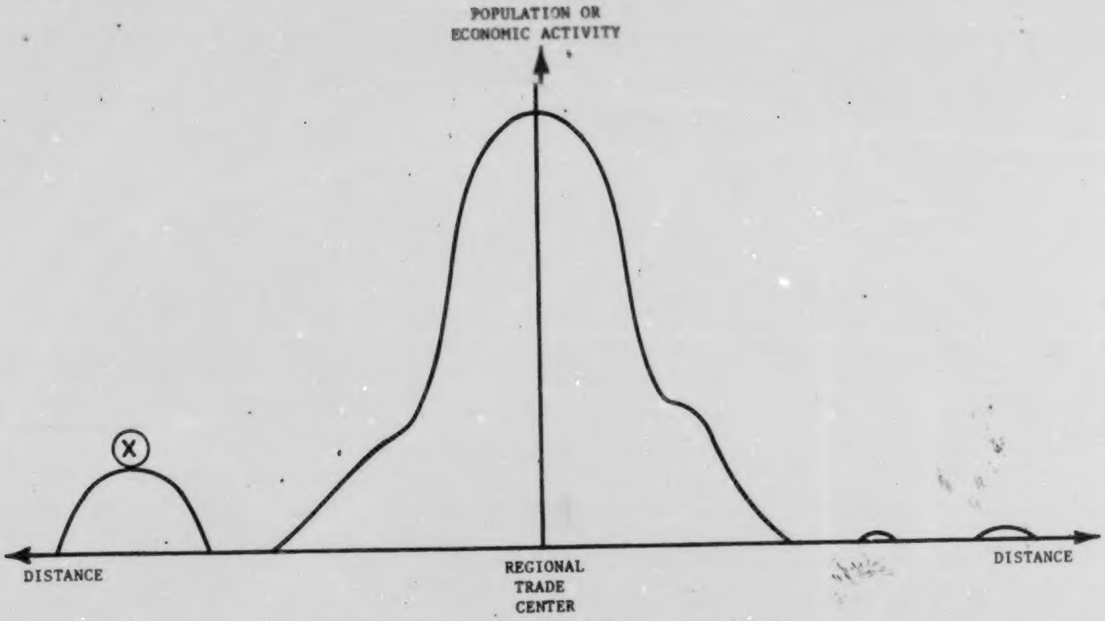
POPULATION OR
ECONOMIC ACTIVITY
X
DISTANCE
REGIONAL
TRADE
CENTER
DISTANCE

FIGURE III-3

EXPECTED POPULATION DISTRIBUTION AS LINEAR MOVEMENT OCCURS AWAY FROM A REGIONAL TRADE CENTER IN THE INTERMOUNTAIN REGION

TABLE III-1

ILLUSTRATIONS OF POPULATION VARIATION WITH RESPECT TO VARIATION IN THE LEVEL OF ECONOMIC ACTIVITY

Community	Population	Level of Economic Activity[a]
A. Communities of Similar Size, and Differing Levels of Economic Activity		
Fort Morgan, Colo.	7,594	0.453
Rawlins, Wyo.	7,855	0.323
Lander, Wyo.	7,125	0.233
Vernal, Utah	3,908	0.315
Green River, Wyo.	4,196	0.137
B. Communities of Different Size, and Similar Levels of Economic Activity		
Laramie, Wyo.	24,700	0.629
Sterling, Colo.	10,636	0.604
Sidney, Neb.	6,403	0.393
Rock Springs, Wyo.	12,100	0.391
Rawlins, Wyo.	7,855	0.323
Vernal, Utah	3,908	0.315
C. Communities of Similar Size, Different Levels of Economic Activity, and Different Distances from the Nearest Regional Trade Center		
Billings, Mont.	61,581	2.409
Boulder, Colo.	69,279	1.758
D. Resort Communities versus Non-resort Communities for Different Populations and Similar Levels of Economic Activity		
Vail, Colo.	484	0.145
Heber, Mont.	3,245	0.147
Estes Park, Colo.	1,616	0.487
Fort Morgan, Colo.	7,594	0.453

[a] The level of economic activity is described later in this chapter under the heading "centrality index."

State licensing rosters were sources of manpower data, except for data on physicians and dentists. These data were obtained from their respective national directories.[6]

Hospital data were obtained from the American Hospital Association's Guide Issue. Nursing home data were taken from state directories, and medical laboratory information came from the Bureau of Health Insurance listings of Medicare approved medical laboratories.

A difficulty with the health data (and economic data as well) was either the absence of data from one of the six states or the lack of comparability of the data. For example, while some states listed active and inactive physicians separately, others simply listed licensed physicians. The health data were subject in their accuracy to the deficiencies of the collecting procedures used by agencies which are not data collecting bodies per se. When possible the data were checked against the WICHE Health Profiles.

D. QUANTITATIVE TECHNIQUES

In recent years, quantitative techniques have been applied to the task of hierarchically grouping central places. The individual most responsible for developing computer techniques applicable to this kind of problem has been B. Berry (Berry, 1960, 1962, and 1967a,b,c). The quantitative methods used in this study were of the same nature as those suggested by Berry, but often differed in detail and purpose.

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[6] Samples were taken for Salt Lake City and Denver and expanded to represent a total count.

There were three steps in the quantitative process of forming a hierarchical classification of places: (1) factor analysis to highlight the significant combinations of variables which can be used to describe the economic structure; (2) dimensional analysis to reduce the values of the variables as they occur for each place so that similarities between places might be determined; and (3) grouping analysis to combine similar places into groups (Berry, 1965, p. 78; Horton, 1966). The methods by which these steps were accomplished in this study are the subjects of this section. The explanation proceeds in terms of the economic data--the same procedures were used with the health data.

1. Factor Analysis

The values of each of the 114 economic variables were recorded for the 538 places in the study area. Since 114 variables were unmanageable, the number was reduced by three procedures. First, if the data for a particular variable were not particularly clear, then that variable was either removed or combined with another variable. For example, miscellaneous retail stores were removed since the data sources listed them under other headings. General line grocery stores, frozen food stores, and grocery and related products stores were combined because of the difficulty of making the distinction in the data sources.

The second procedure for decreasing variables was their elimination on the basis of intercorrelation with other variables. For example, book stores and stationery stores usually occurred together, so they were combined into a single variable.

The third variable decreasing method was elimination using factor scores obtained from a factor analysis. A principal axis factor was performed and three factors rotated to yield the factor matrix. The variables chosen were those for which at least 50% of the variance was explained by any of the factors.

The result of the above three procedures was to reduce the number of variables from 114 to seventy-four.

2. The Dimension Problem and Grouping Methodology

The objective of the grouping methodology was to group communities such that intra-group differences would be minimized, and inter-group differences would be maximized. Attainment of the objective was a two-fold problem--reduction of the seventy-four variables (or dimensions) to understandable proportions and determination of a grouping technique.

The technique initially appearing to have the potential for optimally combining communities into hierarchical groups was combinatorial programming (Scott, 1971). Combinatorial programming provided solutions to the hierarchical grouping problem. An example is shown in Figure III-4. The figure was constructed on the assumption that four communities (A, B, C and D) were to be optimally combined to satisfy some objective, given a measure of centrality for each community. The combinatorial programming methodology provided a calculation of all possible groupings which met the objective specified by the analyst. Unfortunately, the large amount of data in this study and the large number of communities included in the intermountain study region precluded the use of exact combinatorial methods. A.J. Scott has suggested that:

> the combinatorial explosiveness of so many problems remains a forbidding obstacle to the application of exact solution methods. It is indeed doubtful if the branch and bound or backtrack programming algorithms could handle any problem with much more than ninety or a hundred variables...it is often the case that combinatorial problems can only be solved by sub-optimal approximations,

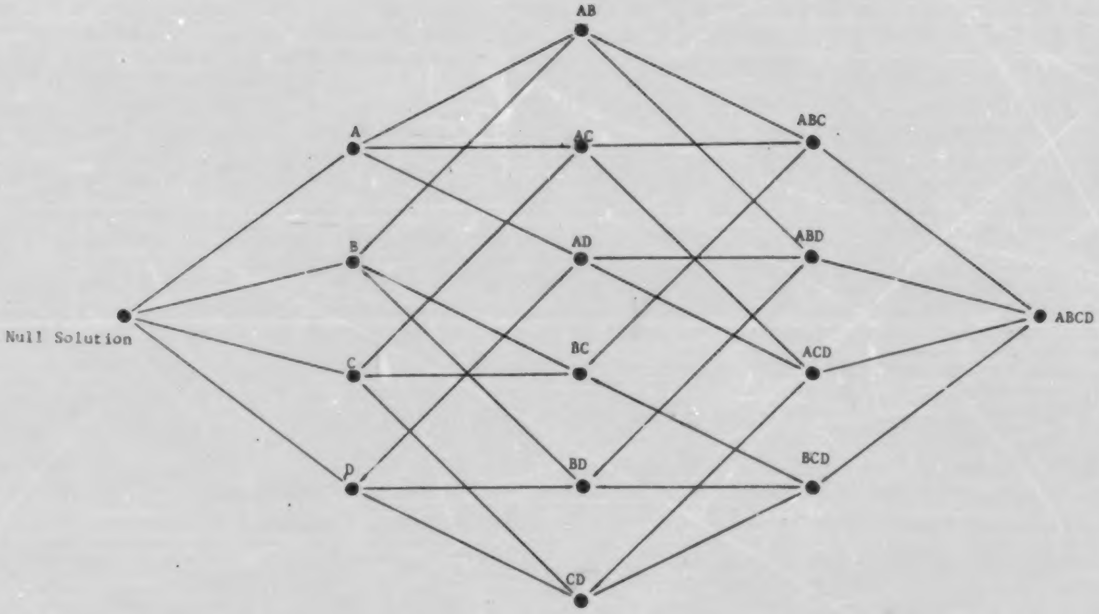
AB
A
AC
ABC
B
AD
ABD
Null Solution
BC
ABCD
C
ACD
D
BD
BCD
CD

FIGURE III-4

NUMBER OF COMBINATIONS FOR ONE ECONOMIC ACTIVITY AND FOUR COMMUNITIES

($2^4 = 16$, including the null solution)

> where exactness of the final solution is sacrificed for the sake of computational tractibility. The solution of programming problems by approximation falls generally within the class of computational methods known as heuristic programming. (Scott, 1971, pp. 36-7).

The number of activity locations in the region was 538, and the economic data included seventy-four variables. To have used exact combinatorial programming methods to obtain the optimum combination of 538 communities and one variable, the total number of combinations required would have equaled 2^{538} (including the null solution). This would have required an approximate number of combinations equal to 90,000 followed by 157 zeros!

In view of the data processing limitations imposed by both time and storage capacity, a sub-optimal method of areal delineation (i.e., one attempting the optimum, but not necessarily achieving the optimum) was selected. The specific programming algorithm chosen was developed by Joe Ward (Ward, 1963). The expectation was that this algorithm would provide a sub-optimal solution that would converge toward the optimum.[7]

The Ward Algorithm required the minimization of the error sum of squares, ESS, for some variable X_i. The objective function was written:

$$\text{Minimize ESS} = \sum_{i=1}^{n} X_i{}^2 - \frac{\left[\sum_{i=1}^{n} X_i\right]^2}{n} \qquad (1)$$

---

[7] Theoretically, it was possible that the Ward Algorithm would provide a different solution for successive runs on the computer. Practically, the data were organized in rank-order form prior to the commencement of the analysis with the result that this modification provided the same hierarchical result for repeated runs on the computer.

The computation began with n groups in the hierarchy. Subsequent computations resulted in the combination of the n groups into a smaller group, for example, k (k is the parameter defining the number of groups chosen for the system of cities studied). For the data reported herein, the number of groups was assumed to be seven (k=7). Therefore, the generalized form of the objective function was:

$$\text{Minimize } ESS_{(k \text{ groups})} = ESS_{(\text{Group } 1)} + ESS_{(\text{Group } 2)} + \ldots ESS_{(\text{Group } k)} \tag{2}$$

The Ward Algorithm began with k=538 ($ESS_{k = 538} = 0.0$) and combined communities until k=7. Communities were combined such that no other combination could have produced a smaller increase in the value of the objective function. Since all combinations were not included when this algorithm was used, the final solution would have a higher objective function value than if all combinations had been used (see Scott, 1971, Ch. 9).

Since the algorithm permitted the computation of a hierarchy with one variable at a time, it was necessary to compute a different hierarchy for each variable. Rather than to compute a different hierarchy for each variable and then to find an average hierarchy, the variables were collapsed into a single and proportional index of centrality, C_i.[8] If X_{ij} is the number of establishments for Standard Industrial Classification (SIC) code j (j = 1,..., n) in community i (i = 1,...,m), then a proportional weight for each type of business, P_{ij}, can be computed for each community as follows:

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[8] Two indexes of centrality were computed: one for the economic variables and one for the health system variables.

$$P_{ij} = \frac{X_{ij}}{\sum_{i=1}^{m} X_{ij}}, \tag{3}$$

where.

P_{ij} = is the proportional weight contributed to community i by business establishments of type j.

The proportions are then summed over each j to compute C_i,

$$C_i = \sum_{j=1}^{n} P_{ij} \tag{4}$$

The variable C_i is a centrality index for each community and is similar to those computed by W. Davies (1967) and J. Marshall (1969). The single index of centrality is used in conjunction with the Ward Algorithm to compute a hierarchical system among the n communities.[9]

The single proportional variable, as defined above, requires a strong assumption: each economic activity defined by an SIC code is, in the aggregate, of equal importance to any other economic activity in the economic system. For example, in the analysis reported herein, the eighty-six bicycle stores would have the same weight as 632 new and used-car dealers.

The effect of the centrality index is not inconsistent with the conclusions of central place theory since scarce activities will increase the

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[9] A similar procedure was used to compute a health-care delivery index, HC_i:

$$HC_i = \sum_{j=1}^{n} P_{ij} = \frac{Y_{ij}}{\sum_{i=1}^{m} Y_{ij}}$$

where

Y_{ij} = is the numerical value of some health-care variable i in community j.

influence of a community as a central place. The centrality index incorporates this concept by giving more weight to an establishment performing a rare activity than to an establishment performing a more ubiquitous activity. Incorporated, in addition, is the idea that communities with a greater number of establishments of any one business type should also have a greater influence as a central place.

A final methodological comment on the determination of the number of hierarchical groups is appropriate. The suggestion in the literature is that instead of specifying the number of hierarchical groups, the methodology is a search for the optimal number of groups for the study area (Berry, 1967c; Mayfield, 1967; Lewinski, 1968). In this study, the objective was the optimization of a given number of groups. The number of groups utilized was seven. To justify that number, the following statement by Berry in the International Encyclopedia of the Social Sciences is noted:

> Most students suggest that the urban hierarchy has eight levels in advanced Western economies, roughly: the national capital; national metropolitan centers; regional metropolitan centers; regional capitals; small cities (e.g., county seats); towns; villages; and hamlets. A possible ninth level is that of the world city, such as New York or London. (Berry, 1968).

If Denver is considered a national metropolitan center, then seven groups in the study region are consistent with the above statement. Moreover, the seven group hierarchy employed in this study conforms to the conclusions of the hierarchical studies of Saskatchewan (Hodge, 1965) and Minnesota (Borchert, 1963)--two regions which appear to be similar to the intermountain study area.

E. DELINEATING ECONOMIC SERVICE AREAS

The delineation of service areas or areas of influence was linked to decisions made with respect to two questions: (1) what kind of influence was to be used as the conceptual basis for delineating areas, and (2) what criteria were to be used in drawing boundary lines.

1. Conceptual Basis

The primary concern in this study was to determine retail market areas--the distances consumers travel for various hierarchical goods and services. For example, an electrical appliance store would serve customers travelling greater distances than would a general merchandise store, since electrical appliance stores occur less frequently and only in communities of higher rank in the central place system. These higher ranked communities were expected to have larger areas of influence. The information concerning consumer distances travelled was found in data on goods purchased and on types of establishments frequented. In the absence of data on consumer purchases and distances travelled, this study utilized newspaper circulation data to infer the distances travelled for retail purchases. The resulting areas delineated were called Service Areas. Also, the areas drawn were for communities and reflected the types of goods and services sold in communities.

2. Construction of Boundaries

The criteria used in drawing boundaries for service areas were the results of two definitions. First, absolute service area was defined as the area over which the community has any influence. If any retail buying by residents in an outlying area was done in a particular community, it was considered part of that community's service area. Second, the relative service area was defined as the area over which a community had greater influence than any competing community. The extent to which either of these concepts is used involves the characteristics of the study region and how competing and noncompeting communities are defined.

Returning to the concepts of central place theory, communities of a higher order in the hierarchy sell goods and services of a higher order--those for which consumers are willing to travel farther. The assumption was in this study that the goods of highest order sold by a community determined the size of the service area. Therefore, the service areas of higher order communities were expected to be larger than for lower order communities. Also, communities at any level in the hierarchy do not compete with any communities below or above them in the hierarchy because the areas of the lower and higher communities are not determined by the same level of goods and services. But, communities do compete with other communities in their own group, since their areas are determined by essentially the same goods and services.

Initially, the absolute Service Areas were constructed from newspaper circulation data (discussed below). These areas were altered only if the areas of two communities in the same group overlapped. This alteration involved constructing a boundary between the two areas connecting points of equal service strength.

Newspaper Data

The newspaper data used in delineating areas of influence in the Wyoming intermountain study region were obtained from Audit Bureau of Circulation (ABC) audit reports for daily (excluding Sunday) circulation of newspapers in 1971. Data were collected for twenty-nine communities in which daily newspapers were published.

There are three reservations concerning the employment of newspaper data, aside from the possibility of inaccurate reporting. First, the use of newspaper circulation data assumes that consumers respond to newspaper advertising in their purchases of goods and services. Second, it is accepted that the newspapers advertising in different communities reflect the goods and services characteristics of the different hierarchical levels. Third, the ABC audit reports show circulation only in communities receiving at least twenty-five copies of the particular newspaper. Consequently, the newspaper circulation in very small communities does not show in the data thus preventing accurate assignment of these communities to the market areas of higher order markets.

While these reservations weakened the quality of inferences made from the data, they did not warrant the substantial expense of field surveys in the study region. The assumption that consumers respond to advertising in making purchases is probably accurate. In fact, earlier studies have confirmed this (Converse, 1946: Reilly, 1929: Park, 1933).

The newspaper data were processed by recording the names of the newspapers and total circulation in each community receiving daily newspapers from the twenty-nine publishing cities in the region. A computer map of the region showing each central place was programmed and the data mapped for each of the newspapers. Each of the twenty-nine maps indicated the percent of dailies received in each community attributable to the newspapers from a particular publishing city.[10]

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[10] The Denver Post and Denver Rocky Mountain News data were combined to obtain totals for Denver. This was the only city for which it was necessary to combine data.

Service areas were drawn taking into account the percent of newspaper circulation, the structure of the highway system, and geographical barriers which might influence consumer orientation. Specific deviations from newspaper circulation boundaries are discussed in the Service Areas section of Chapter IV.

CHAPTER IV

THE ECONOMIC SYSTEM

In order for the methodology proposed in this study to be a useful planning tool, the results must be capable of meaningful interpretation. Therefore, the purpose of this chapter is not only to describe the results of application of the methodology to the study region, but to investigate the implication for planning purposes.

This chapter is composed of five sections. In the first, characterization of the study region is presented. The second section is a discussion of the results of the hierarchical grouping of communities. The third section is a listing of propositions employed for further interpretation of the results of the grouping procedure. The application of the propositions to empirical results in the study region is discussed in the fourth section. In the fifth section, the results of the methodology employed in constructing Economic Service Areas for the region are discussed and compared with regional maps of Rand McNally Trade Areas, BEA Economic Areas, and Functional Economic Areas.

A. CHARACTERISTICS OF THE STUDY REGION

A map of the study region has been included in the previous chapter as Figure III-1. The land area of the region is 230,451 square miles which is similar in land area to the summed land areas of Connecticut, Massachusetts, Rhode Island, New York, New Jersey, Pennsylvania, Ohio, Delaware, Maryland, Virginia, West Virginia, and the District of Columbia (combined land area of 230,814 square miles). The populations of the two regions, however, are unequal.

The study region has a 2,770,000 population with a population density of 12 persons per square mile, while the Eastern region has a 69,138,000 population with a density of 300 persons per square mile.

Table IV-1 includes some additional comparative information on the study region versus the United States. According to Table IV-1A, the study region contains 6.3% of the total land area and 1.2% of the total population. Further, the population density in the study region is approximately one-fifth of the United States average.

In Section B of Table IV-1, the study region is shown to have a lower percentage of all community size ranges except for the less than 1,000 range. In general, the inference is that the study region is less urban than the United States.

B. THE HIERARCHICAL STRUCTURE OF CENTRAL PLACES IN THE STUDY REGION

The quantitative procedures by which the central place hierarchy was identified have been described in detail in Chapter III. The resultant seven hierarchical groups for the study region have been included as Appendix C. Analysis of the characteristics of central places in each of the groups allowed the following names and general descriptions to be given.

1. Group 1, G_1 -- Regional Trade Centers

A regional trade center has the following characteristics: (a) performance of all of the economic activities (functions) found in lesser trade centers is definite; (b) a fully developed infrastructure is evident (i.e., airports, highway system, public utilities, etc.); (c) as the focal point in the region, it dominates in both population and economic magnitude by a ratio

TABLE IV-1

COMPARISON OF THE INTERMOUNTAIN REGION TO THE UNITED STATES

A. General Characteristics

	Total Population	Total Land Area (square miles)	Population Density	Total Central Places
Intermountain Region	2,797,700	230,451	12.1	545
United States	230,211,900	3,536,855	65.1	20,768
Region/U.S. (%)	1.2	6.3		2.6

B. Central Place Characteristics

Central Places (population ranges)	Intermountain Region		United States	
	Number of Central Places	Percentage of Total	Number of Central Places	Percentage of Total
100,000 or more	4	.7	396	1.9
25,00 - 99,999	9	1.7	1,905	9.2
1,000 - 24,999	104	19.1	8,952[a]	43.1
999 or less	428	78.5	9,515	45.8
Totals	545	100.0	20,768	100.0

[a] It was assumed that the 627 urban places in the United States with a population below 2,500 had populations between 1,000 and 2,499.

Source: Statistical Abstract, 1972.

of at least 2:1; and (d) it is a major metropolitan area playing a greater role in shaping opinions on current issues through the news media (radio, TV, and newspapers) penetrating into adjacent states.

2. Group 2, G_2 -- Sub-Regional Trade Centers

These characteristics are displayed by a sub-regional trade center: (a) all economic activities (functions) found in lesser trade centers are performed; (b) a fully developed infrastructure is present; (c) although overshadowed in magnitude by the regional trade center it offers the same range of economic functions, though on a smaller scale; and (d) influence of opinions on current issues is possible through the news media (radio, TV, and newspapers) penetrating into adjacent states.

3. Group 3, G_3 -- Wholesale/Retail Centers

A wholesale/retail center has the following characteristics: (a) all of the economic activities (functions) found in lesser trade centers are available; (b) a wide range of wholesale and retail activities is present but the extent of penetration into the region is much less than for either regional trade centers or sub-regional trade centers; and (c) these centers have some influence on current issues through the media but the influence is less than for the regional and sub-regional trade centers.

4. Group 4, G_4 -- Primary Shopping Centers

A primary shopping center is possessed of these characteristics: (a) all of the economic activities (functions) found in lesser trade centers are performed; (b) fewer wholesale services, but a full range of retail services are provided; and (c) its trade area and area of influence are restricted to adjacent counties.

5. Group 5, G_5 -- Secondary Shopping Centers

The characteristics of a secondary shopping center are: (a) all economic activities found in lesser trade centers are available: (b) few wholesale services are provided and some retail activities are not present; and (c) its trade area and area of influence are restricted to the immediate county.

6. Group 6, G_6 -- Convenience Centers

Wholesale services are rare in these communities and many retail activities are missing. These centers do not have daily newspapers and have populations in the 3,000-5,000 range.

7. Group 7, G_7 -- Minimum Convenience Centers and Hamlets

Wholesale activities are virtually absent and most communities have only convenience services (e.g., service stations, general stores). These centers are small in size, usually less than 1,000 population. On the average they have ten businesses. Further, these places are not, strictly speaking, central places.

C. ANALYSIS OF MARGINAL INTER-GROUP DIFFERENCES

While the above section is a description of the broad characteristics of central places within each of the seven groups, a more specific differentiation is needed between the groups. A closer analysis of group characteristics would allow inductively determined generalizations of the criteria for inter-group movements. The task in this section is the development of a conceptual framework for discussing inter-group differences and the resulting inferences for inter-group movements.

Mentioned in Chapter II is one of the important tenets of central place theory: centers of each higher group perform all of the functions of lower groups, plus additional functions that distinguish them from the lower-grouped centers. For any inter-group movement upward or downward in the hierarchical system, there exist "hierarchical marginal goods" (activities) which are added to or subtracted from the original nucleus of activities. Although these kinds of activities are recognized in the literature of central place theory and although attempts have been made to identify these activities, a formal and generalized method of analysis does not exist.

In addition, it has been argued in Chapter III of this study that the hierarchical ordering of central places is also influenced by the number of business establishments contained. In summary, there are two factors influencing the location of community i in Group k: (1) the presence or absence of each economic activity and, (2) the magnitude of each economic activity. Using these factors, the four propositions below are advanced to provide an operational dimension for classifying differences between groups of central places.

1. Proposition 1: The Ordering of Economic Goods

> Any set of economic activities can be arranged from the highest order of economic activity to the lowest order of economic activity.[11]

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[11] Although a range of economic activities might be either cardinal or ordinal in nature, in this section a combination of both cardinal and ordinal was used to identify the complete order of goods.

The order of economic activities is subject to two major forces: (a) population (both within the central place and in the dependent hinterland), and (b) entry restrictions (e.g., banks are regulated while service stations are not). Higher-order economic activities include corporate leadership for national and multinational corporations, while lower-order economic activities include the ubiquitous activities identified by Philbrick (1957): (a) infrastructure (I), considered a surrogate for transshipment and defined to include highways, air freight, radio stations, and newspapers: (b) wholesale (W) activities; (c) wholesale/production (WP) facilities, including activities in which the same business engages in both wholesale and production activities (some of the output may be sold directly to consumers) such as meat processing, cement and cement products production, bottling plants, and oil refineries; (d) specialized retail outlets (S), encompassing jewelry stores, sporting goods stores, and used-car dealers: (e) convenience retail outlets (C), covering such ubiquitous retail outlets as restaurants and service stations; and (f) specialized/convenience retail outlets (SC), including retail outlets which can be differentiated from S and C retail outlets as having different characteristics.[12] This set of seven elements is represented along a continuum as in Table IV-2.

2. Proposition 2: Inter-Group Marginal Economic Activities

Given a hierarchical economic system, the entire set of economic activities will be found in central places belonging to the highest

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[12] To distinguish between S, SC, and C retail outlets, which represent differences along some continuum, see Figure IV-1. The heuristic programming algorithm was used to group the retail outlets' activities for three groups such that the error sum of squares was minimized.

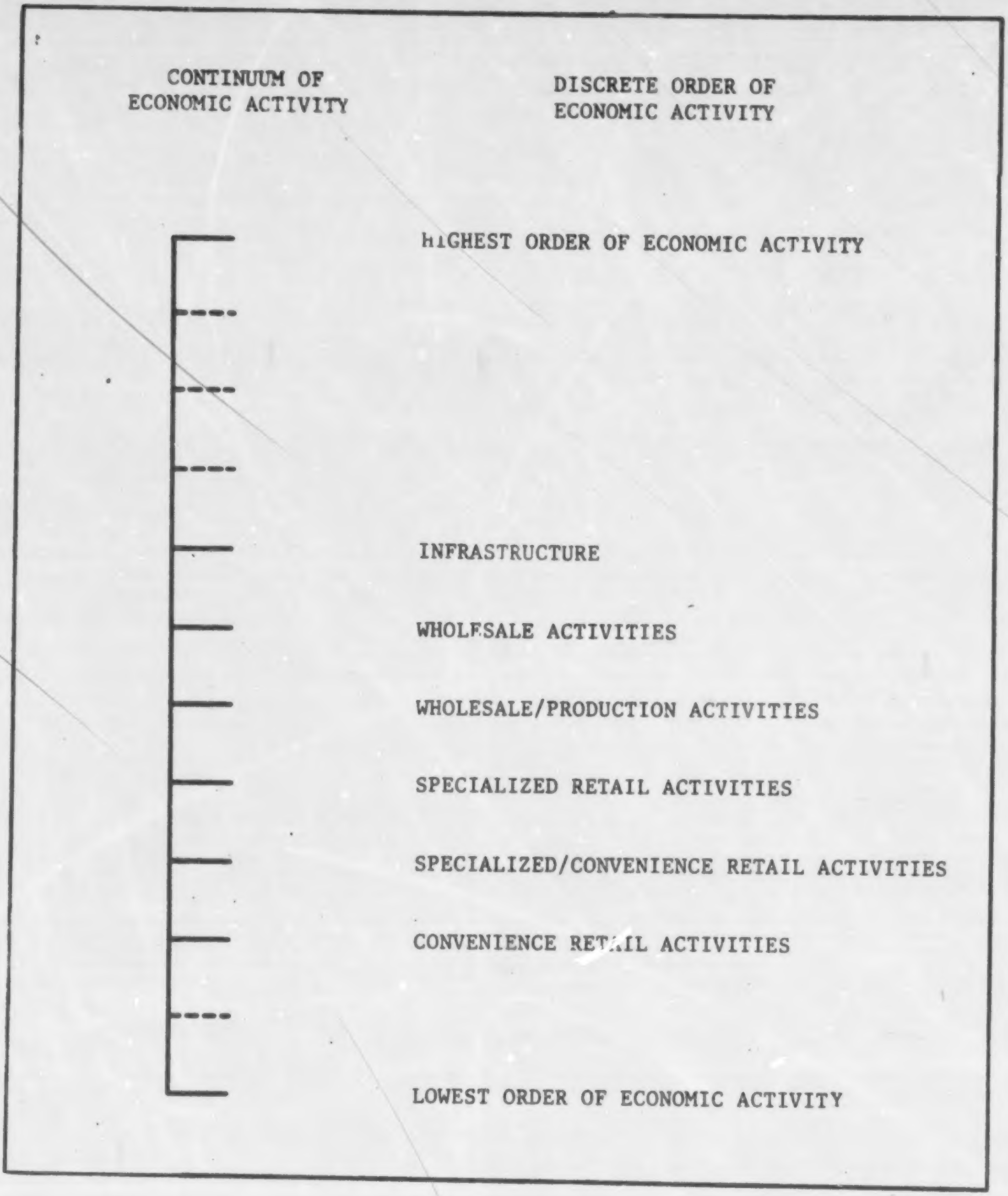
CONTINUUM OF ECONOMIC ACTIVITY
DISCRETE ORDER OF ECONOMIC ACTIVITY
HIGHEST ORDER OF ECONOMIC ACTIVITY
INFRASTRUCTURE
WHOLESALE ACTIVITIES
WHOLESALE/PRODUCTION ACTIVITIES
SPECIALIZED RETAIL ACTIVITIES
SPECIALIZED/CONVENIENCE RETAIL ACTIVITIES
CONVENIENCE RETAIL ACTIVITIES
LOWEST ORDER OF ECONOMIC ACTIVITY

FIGURE IV-1

A CONTINUUM OF ECONOMIC ACTIVITY VERSUS A DISCRETE ORDER OF ECONOMIC ACTIVITY

> order group. For movement down the hierarchical system from group to group, the order and magnitude of economic activities performed become less for each group.

On the basis of Proposition 2, groups can be differentiated by the order of economic activities they perform. For instance, if a central place should move upward from its original group to another, it would be expected that one or more higher-order activities would be added to the original intra-group nucleus, and that there would be an increase in the number of businesses in the original set of intra-group activities. On the other hand, if a central place should move from its original group to the next lower group, it would be expected that there would be a decline in the number of businesses and the number of economic activities as some of the previous activities could not be supported by the lower level of economic activity. The economic activities added or subtracted due to inter-group movement are described as inter-group marginal economic activities (IMEA's).

3. Proposition 3: Magnitude of Inter-Group Economic Activities

> If the members of any two groups in a hierarchical economic system perform the same order of activities, then the magnitude of the activities performed by the members of the higher-order group will be greater than the magnitude of the activities performed by the lower-order group.

In using Propositions 2 and 3, it can be inferred that there are two conditions for inter-group movement for some community i. Higher-order activities (Proposition 2) must be added (subtracted) to the nucleus of economic activities performed by community i if it moves to another group. This IMEA condition is a necessary condition for all inter-group movement. For inter-group movement to occur (Proposition 3), the magnitude of economic activity must change as a sufficient condition for any inter-group movement by i.

4. Proposition 4: Necessary and Sufficient Conditions for Inter-Group Movement

> For any inter-group movement, it is necessary that the set of economic activities changes (i.e., IMEA's to be added or subtracted), and it is sufficient that the magnitude of economic activities changes (i.e., increases or decreases in the number of businesses).

Two corollaries follow from Proposition 4.

Corollary 1

> If for some group j, and activity i, if i is present, then all economic activities of lower-order than i are also present.

Corollary 2

> If for some group j, and activity i, if i is not present, then the higher-order activities i-1 through m will not be present.

The above propositions and corollaries should be applicable to any economic system. Although the IMEA's may vary between economic systems due to institutional, cultural, and other differences, the criteria are applicable. The generality of the propositions and corollaries can be illustrated with a 4x4 matrix.

		GROUPS 1	2	3	4
	1	X_{11}			
Order of	2	X_{21}	X_{22}		
Economic	3	X_{31}	X_{32}	X_{33}	
Activities	4	X_{41}	X_{42}	X_{43}	X_{44}

FIGURE IV-2

MATRIX ILLUSTRATION OF THE
ORDER OF ECONOMIC ACTIVITIES

Proposition 1 applies to the economic activities ranked on the left hand side of the matrix in which economic activity 1 is of a higher order than 2, 3, and 4; 2 is of higher order than 3 and 4; and 3 is of higher order than 4. By applying Proposition 2, it is observed that all four orders of economic activity are present for Group 1, and that at least one economic activity is eliminated in moving from Group 1 to Group 2 and so on through Group 4. Proposition 4 requires that this occur as a necessary condition. Proposition 3 requires that, for any row, the magnitude decreases for each group in moving from left to right.

Finally, Corollary 1 requires that if X_{ij} is present (i.e., X_{22}), then all $X_{i+1,j}$ must be present for all i of lower-order (i.e., X_{32} and X_{42}). Corollary 2 requires that if X_{ij} is not present (i.e., X_{34}) then all $X_{i-1,j}$ must be absent for all i of higher-order (e.g., X_{24} and X_{14}). Theoretically, all elements of the matrix to the right of the diagonal would, therefore, be zero.

D. APPLICATION OF THE IMEA ANALYSIS

It was explained in Chapter III that the variable reduction process resulted in the seven group central place hierarchy for the study region formulated from 74 economic variables. To take into account 74 variables in the description and analysis of this large a system became extremely complex. To ease the difficulities in discussing the economic system, the 74-variable system was simulated using a smaller number of economic variables. A combination of factor analysis, step-wise regression, and personal judgment (the latter was used when the two statistical results were inconsistent) was used to reduce the 74 variables to 17 variables.[13] The 17 variables are listed in Table IV-3.

The 17-variable system was more manageable than the 74-variable system, but clear and distinct breaking points in defining IMEA's were more difficult to identify. Nevertheless, this research project was designed to enable the study of a rural region, and the 17 variables did permit the identification for Groups 4 through 7--groups with the smallest average population size and, therefore, representative of a rural economic system.

The average number of businesses for each economic activity and for each group is recorded in Table IV-4. The economic activities have been ranked according to their order in the economic system with the least ubiquitous activities ranked first and the most ubiquitous last. To eliminate the problem of fractional averages (i.e., 0.05), operational rules were

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[13] To test the accuracy of the 17 variables in depicting the economic system, a regression was computed using the centrality index for 17 variables as the dependent variable and the centrality index for the 74 variables as the independent variable. The resulting multiple R was 0.99904 and the R^2 was 0.99807. The t-statistic had a value of 281,252.3.

TABLE IV-2

VARIABLES USED IN THE 17-VARIABLE ECONOMIC SYSTEM

SIC CODE NUMBER	SIC CODE DESCRIPTION
A. WHOLESALE ACTIVITIES	
5022	Wholesale Drugs and Sundries
5041	Wholesale Groceries and Frozen Foods
5072	Wholesale Hardware
5081	Wholesale Commercial Farm Machinery and Equipment
5097	Wholesale Furniture and Home Furnishings
B. SPECIALIZED RETAIL ACTIVITIES	
5231	Paint and Glass Stores
5462	Bakeries
5511	New and Used Automobile Dealers
5661	Shoe Stores
5712	Furniture Stores
5971	Jewelry Stores
8111	Lawyers
C. SPECIALIZED/CONVENIENCE RETAIL ACTIVITIES	
5912	Drug Stores
7200	Personal Services
D. CONVENIENCE RETAIL ACTIVITIES	
5311	Department Stores and Related Stores
5541	Automobile Service Stations
5812	Restaurants

TABLE IV-3

AVERAGE NUMBER OF BUSINESSES BY SIC CODE AND HIERARCHICAL GROUP, 17-VARIABLE ECONOMIC SYSTEM

	HIERARCHICAL GROUPS						
	G_1	G_2	G_3	G_4	G_5	G_6	G_7
WHOLESALE ACTIVITIES							
Groceries & Frozen Food	70.0	34.0	7.3	3.6	1.2	.3	.0
Comm. & Farm Machinery & Equip.	105.0	40.0	4.7	3.4	.8	.2	.0
Hardware	32.0	15.0	2.7	1.0	.3	.0	.0
Furniture & Home Furnishings	97.0	43.0	4.3	1.5	.2	.0	.0
Drugs and Sundries	28.0	17.0	.7	1.2	.0	.0	.0
SPECIALIZED RETAIL ACTIVITIES							
Lawyers	999.0	300.0	83.3	59.1	13.[illegible]	4.2	.2
New & Used Car Dealers	9[illegible]	49.0	18.0	12.2	5.9	2.7	.1
Furniture Stores	160.0	79.0	30.3	14.4	5.1	1.6	.1
Jewelry Stores	101.0	46.0	14.3	8.8	3.4	1.1	.0
Shoe Stores	68.0	29.0	14.7	7.9	2.3	.5	.0
Bakeries	38.0	36.0	7.7	4.6	1.9	.7	.0
Paint & Glass Stores	106.0	85.0	16.0	9.4	3.0	.5	.0
SPECIALIZED/CONVENIENCE RETAIL ACTIVITIES							
Personal Services	999.0	670.0	184.3	88.1	27.7	10.2	.8
Drug Stores	208.0	77.0	29.0	12.9	4.7	2.2	.2
CONVENIENCE RETAIL ACTIVITIES							
Service Stations	750.0	344.0	141.3	74.0	26.0	10.1	1.5
Restaurants	844.0	347.0	112.0	62.5	22.2	8.6	1.3
Department & Related Stores	134.0	45.0	22.0	11.9	6.8	3.1	.6
NUMBER OF COMMUNITIES	1	1	3	8	21	64	440

adopted: (1) for all retail activities in Table IV-3 for which the average was less than 2.0, the element was assigned a value of zero; and (2) for all wholesale activities for which the average was less than 1.0, the element was assigned a zero value. The assumption underlying these procedures was that communities having fewer than two establishments of any retail activity were noncompetitive for that activity. A similar assumption applies to the number 1.0 for wholesale activity.

Another operational rule was that individual economic activities could not qualify as IMEA's. Rather, sets of economic activities were required. For example, the lowest order of economic activity was defined to be the set C = [5541, 5812, 5311]. To give operational meaning to this set definition for economic activities, the assumption was that an activity existed in a central place group if, and only if, 50% or more of the elements in the activity's set were present on the average. The results of the application of the IMEA analysis to Groups G_4 through G_7 in the study region are described below.

1. IMEA Analysis

IMEA for G_7 - G_6

The IMEA for Groups G_6 and G_7 has been formed by combining activity sets S and SC. The average number of business establishments in Group 7 for this combined set of activities is zero (see Table IV-4). Since they are all present in Group 6, the necessary condition for inter-group movement is satisfied. Examination of Table IV-4 also reveals that the magnitude of economic activities increases in every case with movement to

TABLE IV-4

AVERAGE NUMBER OF BUSINESSES BY SIC CODE AND HIERARCHICAL GROUP, 17-VARIABLE ECONOMIC SYSTEM, CORRECTED FOR OPERATIONAL RULES 1 AND 2

	HIERARCHICAL GROUPS						
	G_1	G_2	G_3	G_4	G_5	G_6	G_7
Set W: WHOLESALE ACTIVITIES							
Groceries & Frozen Food	70.0	34.0	7.3	3.5	1.2	.0	.0
Comm. & Farm Machinery & Equip.	105.0	40.0	4.7	3.4	.0	.0	.0
Hardware	32.0	15.0	2.7	1.0	.0	.0	.0
Furniture & Home Furnishings	97.0	43.0	4.3	1.5	.0	.0	.0
Drugs and Sundries	28.0	17.0	.0	1.2	.0	.0	.0
Set S: SPECIALIZED RETAIL ACTIVITIES							
Lawyers	999.0	800.0	83.3	59.1	13.3	4.2	.0
New & Used Car Dealers	92.0	49.0	18.0	12.2	5.9	2.7	.0
Furniture Stores	160.0	79.0	30.3	14.4	5.1	.0	.0
Jewelry Stores	101.0	46.0	14.3	8.8	3.4	.0	.0
Shoe Stores	68.0	29.0	14.7	7.9	2.3	.0	.0
Bakeries	38.0	36.0	7.7	4.6	1.9	.0	.0
Paint & Glass Stores	106.0	85.0	16.0	9.4	3.0	.0	.0
Set SC: SPECIALIZED/CONVENIENCE RETAIL ACTIVITIES							
Personal Services	999.0	670.0	184.3	88.1	27.7	10.2	.0
Drug Stores	208.0	77.0	29.0	12.9	4.7	2.2	.0
Set C: CONVENIENCE RETAIL ACTIVITIES							
Service Stations	750.0	344.0	141.3	74.0	26.0	10.1	.0
Restaurants	844.0	347.0	112.0	62.5	22.2	8.6	.0
Department & Related Stores	134.0	45.0	22.0	11.9	6.8	3.1	.0
NUMBER OF COMMUNITIES	1	1	3	8	21	64	440

higher groups in the system.[14] This fact satisfies the sufficient condition for movements between G_7 and G_6.

IMEA for G_6 and G_5

The activity set forming the IMEA for this inter-group movement is represented by the set S in Table IV-4. In G_6 only 29% of the elements of this set are present, while 86% are present in G_5. Thus, the necessary condition for inter-group movement is satisfied and, given the consistency of increasing magnitudes, the sufficient condition is satisfied as well.

IMEA for G_5 and G_4

Activity set W represents the IMEA for this movement. Twenty percent of the set are present in G_5, while 100% are present in G_4.

The above results are consistent with central place theory since no two groups possess the same IMEA's, and since the magnitudes of the activities for adjacent groups are found to be different. No attempt was made to determine the IMEA's for (a) Groups 3 and 4, (b) Groups 2 and 3, and (c) Groups 1 and 2, since Groups 1, 2, and 3 were considered to be representative of urban places. Furthermore, to identify the IMEA's for these three groups the 17-variable system is inadequate.[15]

2. Evaluation of the IMEA Analysis

Formal attempts to identify the IMEA's are infrequent in the literature of central place theory. The propositions, corollaries, and criteria specified above are attempts to formalize an approach for identification of the inter-group marginal economic activities for a regional system of communities. These attempts are therefore subject to question and revision. Nevertheless, they do define precisely the basis for the identification of the economic activities causing differences of adjacent groups.

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[14] This conclusion was supported by a non-parametric sign test that was statistically significant at the 5% level.

[15] A forthcoming master's thesis by Jeffrey White, University of Wyoming, will identify the IMEA's for the 74-variable system in the intermountain study region.

Accordingly, if the economic system and health-care delivery system are similar, then the IMEA's in the economic system may be used as surrogates for the inter-group marginal activities in the health system. Given the more readily available data on the economic system, the economic IMEA's may be useful in health planning, health manpower planning, and for planning the location of health manpower education facilities and programs.

E. ECONOMIC SERVICE AREAS

The Economic Service Areas delineated for the study region are shown in Figure IV-3. The handling of the newspaper data utilized in the construction of the Service Areas was explained in the previous chapter. Service Areas were constructed for the top five community groups in the hierarchy since these would be adequate for comparisons with other methodologies. The purpose of this section is to discuss and analyze the Economic Service Areas and to compare them with Bureau of Economic Analysis (BEA) Areas, Rand McNally Trade Areas, and Functional Economic Areas (FEA's) for the region.

The most noteworthy spatial feature of the study region is that all of the cities in the top three groups of the hierarchy are located at the fringes of the region rather than at the center. Several consequences arise

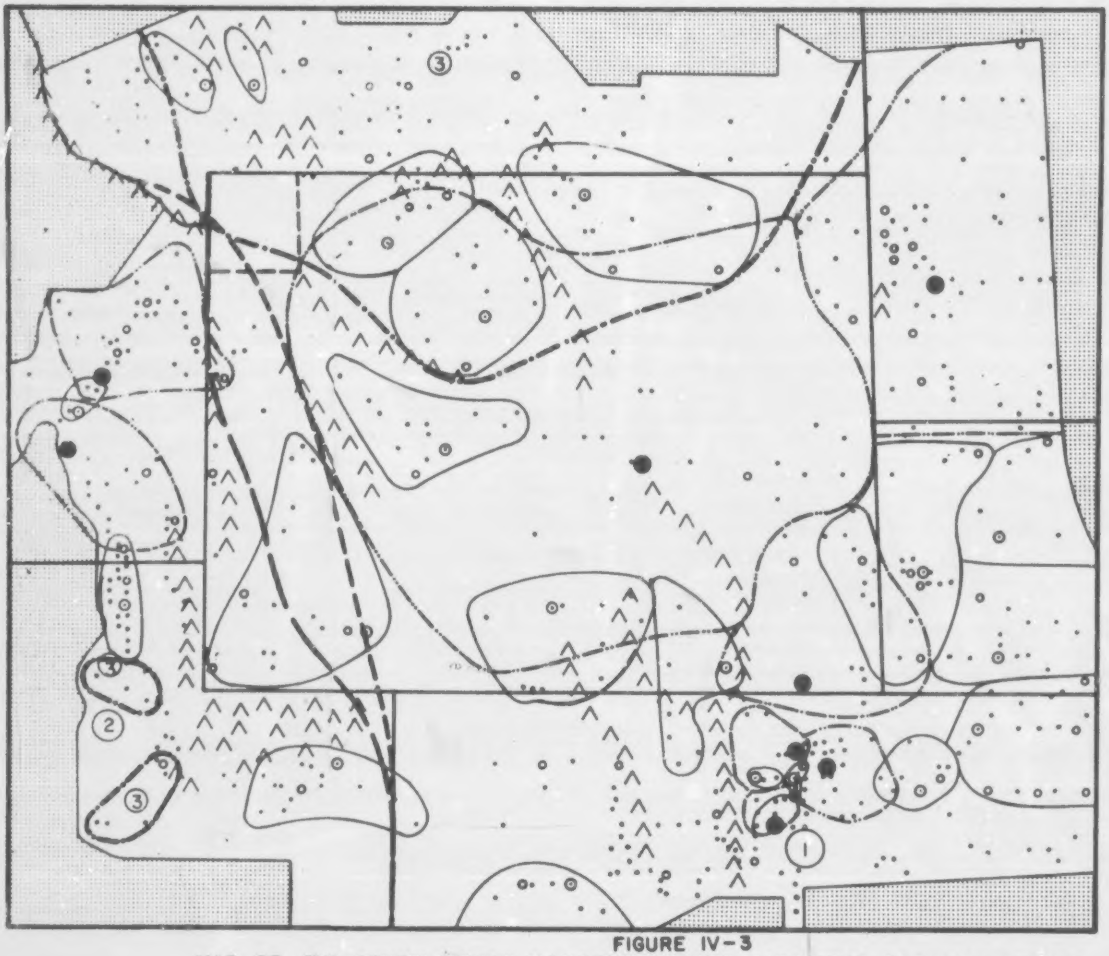

FIGURE IV-3
MAP OF THE STUDY REGION ILLUSTRATING THE ESTIMATED ECONOMIC SERVICE AREAS

LEGEND

CITIES IN:

① - GROUP 1
② - GROUP 2
③ - GROUP 3
● - GROUP 4
◎ - GROUP 5
∘ - GROUP 6
· - GROUP 7
^^ - MOUNTAINS

BOUNDARIES AROUND:

—— —— - GROUP 1
—— — — - GROUP 2
——·—— - GROUP 3
—··—··— - GROUP 4
———— - GROUP 5
———— - STATES

from this peculiarity and each is discussed.

First, the location of higher-order cities at the outer edges of the study region confirms the rural nature of the State of Wyoming. No Wyoming city enters the hierarchy until the fourth group, and then only two appear (Cheyenne and Casper). As a consequence, Service Areas for cities in the top three groups of the hierarchy should extend far into the state. The Service Area map indicates that this is true for Denver and Billings. The Denver influence is strong in southern Wyoming and decreases to the North. However, the Service Area of Salt Lake City penetrates into a fraction of Wyoming due to the mountainous te[illegible]n western Wyoming as well as to the importance of Denver throughout most of the state.

A second consequence resulting from the peculiar placement of upper-group cities is the var[illegible] in sizes of Service Areas for cities in these upper groups. In comparing the areas for the cities in the third group, a large area for Billings, Montana exists but very small areas are indicated for the two other cities in this group--Ogden, Utah and Logan, Utah. The location of Ogden and Logan in a comparatively densely population section of the region and geographic isolation (note the mountains) from the rest of the region have decreased their areal influence. This wide range in Service Area sizes is found in Group 4. For example, compare the area for Boulder, Colorado, located in the dense population of the Denver section of the region, with the area for Casper, Wyoming centrally located in a section with a sparse population density.

Third, the location of higher-grouped cities leads to the suggestion that the study region is not a self-contained hierarchical system. Denver's total Service Area includes much more than the study region. The same will be true for Billings, Salt Lake City, and Rapid City. That these observations are true is not particularly bothersome, however, as the purpose of the study was not to delineate a self-contained central place system. The purpose was to analyze the economic links between residents of Wyoming and their sources for goods and services.

1. Comparison with BEA Areas

The primary difference between the BEA Areas for the study region and the Economic Service Areas is the conceptual divergence with respect to the hierarchical nature of communities. A comparison of the two maps (Figures IV-3 and IV-4) shows notable differences between the numbers of areas. The region encompasses one complete BEA Area and parts of seven more. The Economic Service Areas are thirty-four in number, and all but seven are within the region. Although the BEA Areas do not reflect the hierarchical nature of communities in the region, the Economic Service Areas do. For example, Denver's area of influence in the BEA construction does not extend into the State of Wyoming. In this study, the assertion has been made that for some types of specialized goods and services, Denver's influence extends over most of Wyoming. This is reflected in the Economic Service Area for Denver in Figure IV-3.

A result in the BEA Areas map for the study region is that Cheyenne and Casper are in the same economic area rather than being central cities for two separate areas. Each is approximately twice as large as any other city in the state, and they are about 180 miles apart. While the Economic Service Area map shows that Casper's influence extends over a much greater area, the BEA labels Cheyenne as the central city for the large area containing both cities. The study of newspaper data reveals that Casper's

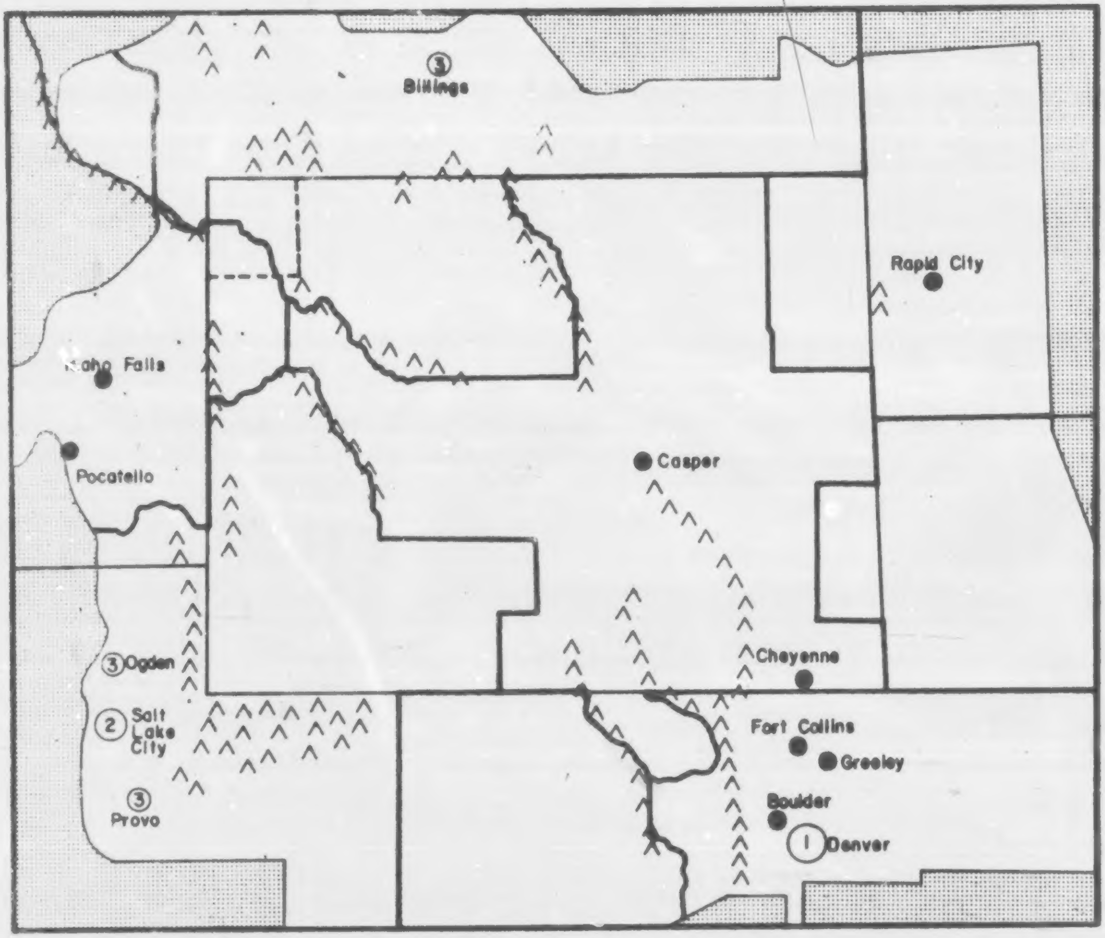
③ Billings
Rapid City
Idaho Falls
Pocatello
Casper
Cheyenne
③ Ogden
② Salt Lake City
③ Provo
Fort Collins
Greeley
Boulder
① Denver

FIGURE IV-4
MAP OF THE STUDY REGION ILLUSTRATING THE BUREAU OF ECONOMIC ANALYSIS AREAS

LEGEND

CITIES IN:

① -GROUP 1

② -GROUP 2

③ -GROUP 3

● -GROUP 4

^^ -MOUNTAINS

influence extends over a much larger area than Cheyenne's. Moreover, even though Casper and Cheyenne are in the same group in the hierarchy, Casper has a higher centrality index than does Cheyenne (see Appendix C).

The BEA Areas make a more geometric and easily read map because the area boundaries are constructed along county lines. Remembering that economic area boundaries do not automatically follow political boundaries, empirical evidence is needed to substantiate the construction. The BEA Areas do not use empirical evidence to justify this procedure.

Finally, as planning units, the Economic Service Areas appear to be more versatile since they allow for a wider range of planning opportunities. Economic growth policies might concentrate upon larger areas in the region and their nodal centers while planning for public services (e.g., health services) would require knowledge of smaller communities and the extent of their service areas.

2. Comparison with Rand McNally Trade Areas and FEA's

Rand McNally Trade Areas and FEA's for the region are shown in Figures IV-5 and IV-6, respectively. Many of the criticisms discussed above for BEA Areas are applicable to Rand McNally Areas and FEA's. An absence of a hierarchical delineation for the study area exists. The areas are fewer in number than for Economic Service Areas and, consequently, show less detail: and the area boundaries follow political boundaries.

A final criticism with respect to FEA's is the amount of area in the study region not included in any FEA. To highlight this feature, the FEA's have been shaded. The v-shaped area in northern Wyoming is not assigned. The use of FEA's as constructed by Berry would make public service planning difficult.

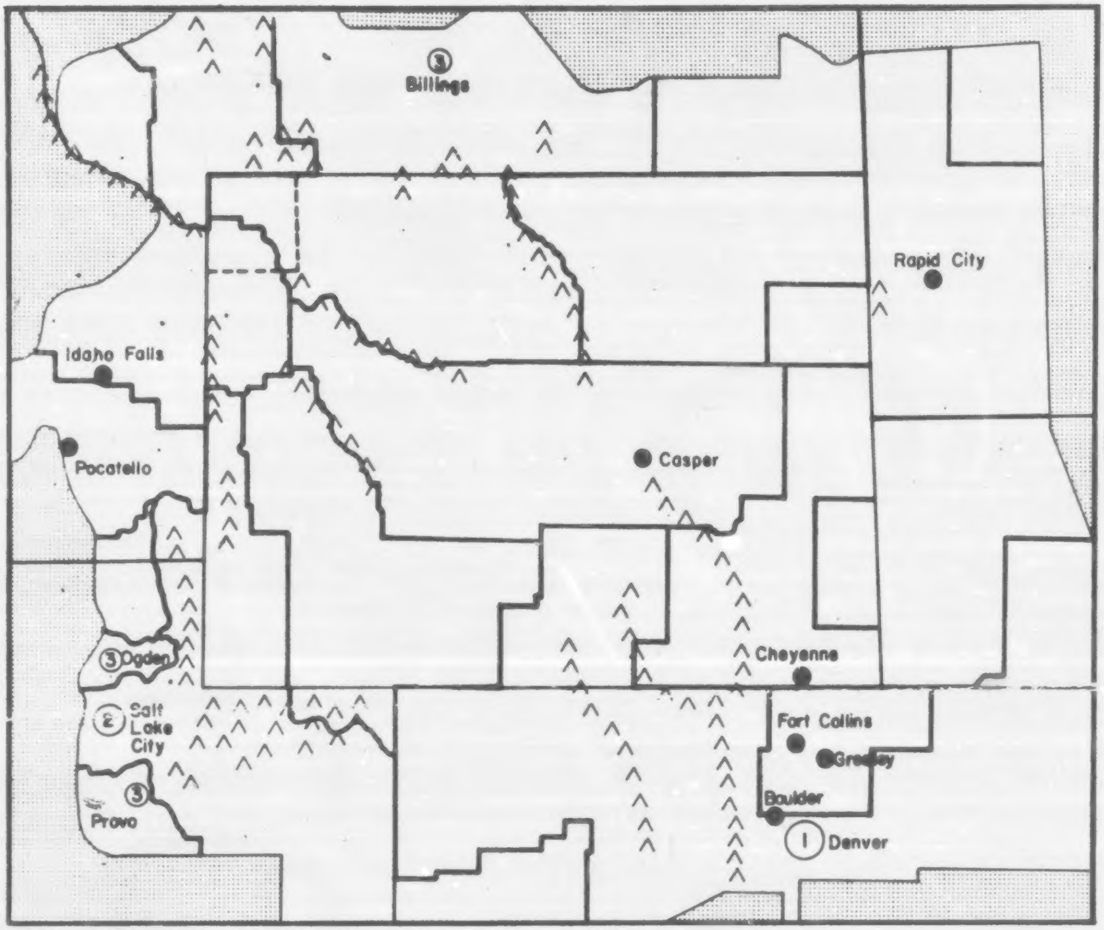
③ Billings
Rapid City
Idaho Falls
Pocatello
Casper
Cheyenne
③ Ogden
② Salt Lake City
③ Provo
Fort Collins
Greeley
Boulder
① Denver

FIGURE IV-5

MAP OF THE STUDY REGION ILLUSTRATING THE RAND McNALLY TRADE AREAS

LEGEND

CITIES IN:

① -GROUP 1

② -GROUP 2

③ -GROUP 3

○ -GROUP 4

^^ -MOUNTAINS

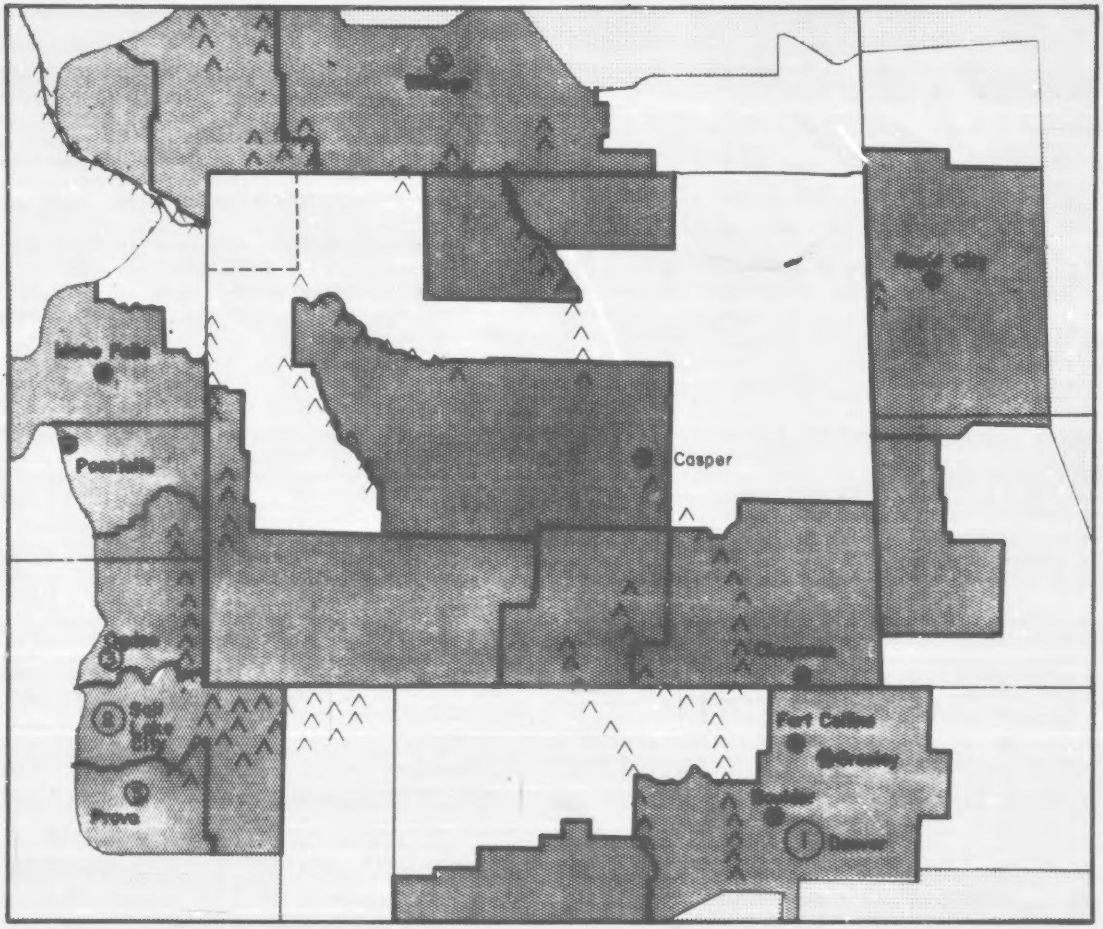
Billings
Idaho Falls
Pocatello
Casper
Rapid City
Ogden
Salt Lake City
Provo
Cheyenne
Fort Collins
Greeley
Boulder
Denver

FIGURE IV – 6
MAP OF THE STUDY REGION ILLUSTRATING THE FEA AREAS

LEGEND

CITIES IN:

① – GROUP 1

② – GROUP 2

③ – GROUP 3

○ – GROUP 4

^^^ – MOUNTAINS

The comparison of four methodologies for the construction of areas of influence leads to the conclusion that Economic Service Areas constructed with newspaper circulation data and a range of economic activities have a more solid empirical basis than the other three, and provide more detailed information than the others.

F. CONCLUSION

Central place theory is, in fact, empirically applicable to a rural region. The results obtained by using the centrality index with the Ward algorithm are encouraging as a method for identifying a regional hierarchical system. Refinements and extensions are necessary if the precise identification of IMEA's is to become operational.

The delineation of Economic Service Areas using newspaper circulation data gives more reasonable results for the rural study region than do other popular formulations, such as BEA Areas, Rand McNally Areas, and FEA Areas.

CHAPTER V

THE HEALTH-CARE DELIVERY SYSTEM

The structure of this chapter and the discussions within the sections are similar to the structure and discussions in Chapter IV. However, a major purpose in Chapter V is the application of the centrality index and the heuristic programming algorithm to data for the health delivery system. Another major purpose of this chapter is a detailed description of health data sources utilized in the study. Health planning and health analysis are complicated by the absence of data sources. This problem is compounded when the region being studied is comprised of parts of several states, as is the case for this study. Consequently, lessons may be learned from the procedures followed in gathering health data.

The chapter is composed of five sections. Section A is a description of the health data sources; Section B is a characterization of the health-care delivery system for the study region in general terms; Section C is an identification of the seven groups of places and service areas in the health-care hierarchy for the region; Section D is an analysis of inter-group marginal differences; and Section E is the conclusion.

A. HEALTH DATA SOURCES

At the onset of the data collecting phase, both quantitative and qualitative data were sought. The quantitative data were comprised of the numbers of health manpower by type, and the numbers and locations of health facilities by type. Qualitative data included age, education, and employment situation (active or inactive) for the health manpower: and the types of services offered by health facilities.

While quantitative and qualitative data were necessary in order to obtain a comprehensive view of the health-care system, a major restriction was placed on the data collection. Since the study area encompassed seven states, the data utilized were restricted to those which could be combined or readily compared.

To gain an overview of the health-care delivery system of the study region, many agencies were contacted. These agencies included the Comprehensive Health Planning agencies in the seven states, the Mountain States' Regional Medical Programs, the Colorado-Wyoming Regional Medical Program, the Intermountain Regional Medical Program, the Bureau of Statistical Services of Utah's Division of Health, Wyoming's Division of Health, the Public Health Service of Colorado, Sweetwater Health Services, Inc. of Rock Springs, Wyoming, the Higher Education Council in Wyoming, the Core Curriculum Program of South Dakota, and the Colorado State Board for Community Colleges and Occupational Education. Members of the various licensing boards were also interviewed regarding the general location and background of health personnel in their respective, occupational field. The researchers also attended a legislative hearing on a proposed medical school for Wyoming. Though the information obtained from these sources was interesting and gave the researchers an understanding of the health-care delivery system, the information could not be correlated and, therefore, could not be incorporated into a statistical regional analysis.

1. Health Manpower Data

Only two sources were found to provide both quantitative and qualitative data on health manpower in all seven states--the American Medical Association Directory (1969) and the American Dental Association Directory (1972). The

AMA Directory provided semi-detailed information on physicians, such as their specialty, educational background, and age. The ADA Directory provided similar information on dentists, though this information was not as current. Therefore, for data on the number of physicians and dentists in the study area, the AMA Directory and ADA Directory were used.

Census data were examined, but since the breakdown of information was given only for counties and urban areas, the data could not be used for this study.

For health manpower other than physicians and dentists, the Health Profiles for Idaho, Montana, and Wyoming, published by the Mountain States Regional Medical Program and the Western Interstate Commission for Higher Education, were viewed as possible data sources. The information from these sources was fairly accurate; except that the Idaho and Montana studies, being several years old, were somewhat out-of-date. The other major problem concerning the Health Profiles was that they were not available for Nebraska, Utah, South Dakota, or Colorado.

The various allied health professional associations were contacted for information concerning their respective members; but since not all members of a profession join their respective association, the membership lists were incomplete.

After an extensive review of the available data, state licensing rosters of the allied health occupations were determined to be best suited for the data needs of the study. The count of health personnel was tabulated by the community of residence listed in the rosters. This count presented a fairly accurate number of health personnel within a community and prevented any counting of health personnel licensed from out-of-state.

The information from the rosters did represent gross numbers of health manpower. From the information obtained in the licensing bureaus' files of one state, a small percentage of the licensed manpower was found to be inactive in their respective professions. For example, many of the licensed nurses were not actively working in nursing. Since the majority of nurses are female, the assumption was that some leave their field temporarily to become housewives and mothers. A survey of L.P.N.'s conducted by the Bureau of Statistical Services of Utah's Division of Health showed large numbers of active nurses in the below-30 age bracket, a decrease of active nurses between the ages of 30 and 40, and an increase of active L.P.N.'s in the over-40 age bracket. The results of the survey indicate that nurses do leave their profession at some time to raise families but remain licensed with the intention of returning to work.

The use of figures for actively employed manpower might be more accurate for the study. Due to the long time period needed to collect this data, it was not attempted. Moreover, there were other obstacles to obtaining these data. One state licensing bureau refused access to the record files; while another state bureau, in the process of converting over to data processing, did not have the information available.

The use of state or county percentages of unemployed health manpower to adjust the figures for communities was considered but was ruled out since the percentages could not be applied to cities and towns having only one or two health personnel. The methodology for computing the health index was derived from relative values. As long as the percentage of inactive manpower was constant across the region, the results would not be altered. Admittedly, such an assumption was not realistic. However, the alternative was to adjust all figures downward by some percentage in order to approximate active manpower. Decreasing the absolute number of a type of manpower for all communities by the same percentage had no relative effect on the health index.

At the start of the data collection, information was sought on non-licensed health manpower. State licensing bureaus did not have information on such certified occupations as dieticians and medical technologists. The state associations either did not exist, did not respond, or did not have complete listings on the certified manpower working in the state. An extensive survey of every hospital, clinic, and doctor's office would have been the only means of collecting these data. The contract prohibited all survey work; hence, no attempt was made to collect data in this manner

Information was sought on federal physicians and other federal health manpower. Unfortunately, only one state, South Dakota, provided comprehensive information on federal health manpower. Information on the number of federal physicians on Indian reservations was obtained from the Public Health Service in Denver. Information on the federal physicians working in VA hospitals and military installations was sought from those institutions, but information obtained was spotty and could not be correlated. Therefore, due to the incomplete nature of the information obtained on federal physicians, these data were not included in the study.

2. Health Facilities Data

Obtaining information on hospitals, though many sources were available, was more difficult than obtaining information on manpower. Hill-Burton reports contained information on construction of federally-funded hospitals, but no information on facilities within the hospitals.

The bed count from the Hill-Burton reports often did not coincide with the number reported in the American Hospital Association Guide, 1970, 1971, 1972, and the WICHE reports. One reason for the discrepancies was that Hill-Burton only listed the beds supported by federal funds. Another reason was that the hospital administrators answered the various questionnaires differently depending on the purpose of the questionnaire. Information was also obtained from the Bureau of Health Insurance (BHI), but the BHI only listed hospitals that are Medicare/Medicaid approved. Again, the necessity for complete and comparable data for all seven states dictated that the AHA Guide be the source for the hospital information.

The Guide did present some data problems. The figures for the number of beds fluctuated yearly. Several hospitals in the study were listed as "non-reporting" in the 1972 Guide, so the data had to be obtained from the 1970 or 1971 Guides. Some question developed as to the hospital administrators' interpretations of the term "facility." In some instances, a facility was listed only on the basis of ownership of one piece of equipment. Since a sample questionnaire was unavailable, it was not possible to discern the various interpretations of the term "facility."

An effort was made to find detailed information regarding the number of personnel employed in a hospital by occupation. The Guide reported a figure for the total number of personnel working in each hospital, but gave no breakdown for each occupational category. The WICHE studies for Idaho, Montana, and Wyoming did report the number of personnel in the different categories such as pharmacist, dietician, medical technologist, etc.; but there was a definitional problem regarding the status of a consultant versus a part-time employee. Since the data were not available for the other states, the WICHE studies could not be used as a source.

The category of part-time employees presented several problems. In some sources, such as the BHI, full-time equivalents (FTE) were used, while the WICHE studies listed total manpower. Any check for accuracy was difficult. Since the figures from the BHI print-out did not coincide with the total figures listed by the Guide, the assumption was that the Guide reported total manpower, not FTE.

The definition of the different occupations presented further problems. For example, one source stated that there were only eight active, certified dieticians in Wyoming; yet, according to the Wyoming hospitals in the WICHE report, 20 dieticians were working in Wyoming. In most instances, nurses, home economists, or consultants were performing some of the functions of a dietician. If hospitals overstate their health personnel, an accurate count is difficult to obtain. Because problems existed in obtaining information on health personnel in hospitals, the use of the total personnel figures listed in the Guide emerged as the only means to achieve comparable figures for every hospital.

Finding information about nursing homes presented problems. Many nursing homes were reluctant to disclose any information. A listing of Medicare approved nursing homes was obtained from the BHI, but only a small percentage of nursing homes was included. In addition, a definitional problem existed concerning nursing homes. Defined differently in each state, nursing homes were categorized as extended care facilities; intermediate care facilities; supervised care facilities; Intermediate Care I and II; skilled, long-term units; and intensive care units. No information was available concerning the number of personnel and type of facilities offered. In only two states was information available concerning anything other than location of the home and the number of beds. Due to unavailability of information on nursing homes, the following sources were used to obtain the location of nursing homes and the number of beds in each home:

Colorado - Directory of Colorado Health Facilities - Colorado Department of Health - May, 1972;

Idaho - Licensed Nursing Homes - Mimeographed sheets, Idaho Department of Health, October, 1972;

Montana - Pamphlet from Division of Hospital and Medical Facilities, Montana State Department of Health and Environmental Sciences, September, 1972;

Nebraska - A Selected Inventory of Services Offered by Nursing Homes in Nebraska - Nebraska Medicare-Medicaid Project Team, March, 1972;

South Dakota - Health Facilities and Services in South Dakota - Comprehensive Health Planning, State Department of Health, November, 1972;

Utah - Information from Bureau of Statistical Services, April, 1972 letter; and,

Wyoming - Wyoming Health Profile, Mountain States Regional Medical Program, WICHE, May, 1972.

The information on the independent laboratories was obtained from the BHI printout. Though the figures represented only those laboratories which were Medicare/Medicaid approved, these data were the only information that could be obtained for independent laboratories.

B. HEALTH CHARACTERISTICS OF AREA

The most noticeable characteristic of the study region is the concentration of health manpower in the few urban communities. The rural areas have few physicians and, in some instances, at least 100 miles separate the physicians. Considering the mountainous terrain and the vast distances between physicians, some rural residents are hours away from professional medical care.

Many nurses are located in the study area, including some located in communities with populations between 200-500 people. Though these nurses can render first-aid treatment, they are hindered in the use of their full potential, since the law does not permit a nurse to practice without the supervision of a physician.

Hospitals with emergency rooms are widely scattered in the rural area. No statewide ambulatory system exists in the study area. Funeral homes and volunteer rescue squads provide most ambulatory services.[16]

C. THE HEALTH-CARE HIERARCHY

The health-care delivery system was identified by using 24 health-care variables in conjunction with the Ward Algorithm. The heuristic programming algorithm was used to group communities for a health-care index (computed in a manner identical to the centrality index explained in Chapter III) such that the error sum of squares was minimized for within group differences for seven groups in a hierarchical system. Thus, the communities that fell into the same group were more similar to each other than to the communities in adjacent groups for the 24 health-care variables. The list of communities by health-care group is included as Appendix D. The groups are described below.

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[16] Division of Health and Medical Services, Department of Health and Social Services, State of Wyoming, Emergency Medical Services (March, 1972), p. 12.

1. Regional Health-Care Centers

A regional health-care center has the following characteristics: (a) it has all of the health manpower and health facilities found in lesser centers; (b) it is the focal point for health-care and dominates the next largest centers in both the range and magnitude of health-care services; and (c) it is a major metropolitan center playing a major role in shaping approaches to health-care in the region.

2. Sub-Regional Health-Care Centers

A sub-regional health-care center has the following characteristics: (a) it possesses all of the health manpower and health facilities found in lesser centers; (b) it is a focal point for health-care (although it is dominated by a regional health center, the ratio of their health-care indices being more than 2:1) and dominates the smaller centers in both range and magnitude of health-care services; and (c) it has a major role in shaping approaches to health-care in the region.

3. Primary Health-Care Centers

A primary health-care center has the following characteristics: (a) it has all of the health manpower and health facilities found in lesser centers; (b) few higher-order health manpower or health facilities are available; and (c) it has some influence in shaping approaches to health-care in the region from which patient referrals are made.

4. Secondary Health-Care Centers

A secondary health-care center has the following characteristics: (a) it has all of the health manpower and health facilities found in lesser centers; (b) few higher-order health manpower and health facilities are available; and (c) it has little or no influence in shaping approaches to health-care in its immediate service area.

5. Health-Care Convenience Centers

A health-care convenience center provides access to a limited range of health-care services, but does have all of the health manpower and health facilities found in lesser health-care centers.

6. Minimum Health-Care Centers

A minimum health-care center has few health-care services. The services are usually limited to those provided by physicians, dentists, and veterinarians. Small hospitals may be located in these centers.

7. Subminimum Health-Care Centers

A subminimum health-care center has no health-care services.

The seven levels of health-care services defined above are not independent of each other. Individual entry into the health system may occur for a variety of reasons, the most common of which is self-referral to some entry point in the health system. Upon entry at some level, further referrals to different levels may occur in the hierarchical health system. Further, those communities with the highest order of health-care services have the greatest penetration into the hinterland. If, for example, Community H has the only open heart facility in some region, then referrals within the region will either be to Community H or to some other Community Q outside the region. Community Q is part of another health-care delivery system and provides health-care services of the same order or higher than those of Community H.

As was the case with the economic system, a map was prepared of the health-care service areas in the rural region under study (see Figure V-1). The map of the economic region has been included as Figure V-2 to provide an opportunity to compare the service areas for (a) the economic system, and (b) the health-care delivery system. Some observations on this comparison follow. First, there are fewer Health Service Areas than Economic Service Areas. This is due to the smaller number of centers in the top five groups of health-care delivery system as compared to the economic system. Second, the sizes of some of the areas are different. Most notable is the decrease in the size of the Health-Care Service Area for Casper as compared to the size of its Economic Service Area. The reason for this size difference is that Casper's ranking in the health hierarchy falls into Group 5, which is lower than the ranking for the economic system. Casper offers an order of health services which does not rank as high as the order of economic services offered. Consequently, the area's demand for Casper's health services does not extend as far. Similar arguments apply to other deviations between the health and economic service areas in the region.

Operationally, generalizations could be developed that would permit the identification of "inter-group marginal health-care activities" (IMHCA's) that would allow the differentiation of health-care services between groups. For this task, since the health-care system is considered a subset of the economic system, the propositions and criteria used for the economic system should be transferable to the health-care delivery system. This is probably true with one important exception. In the

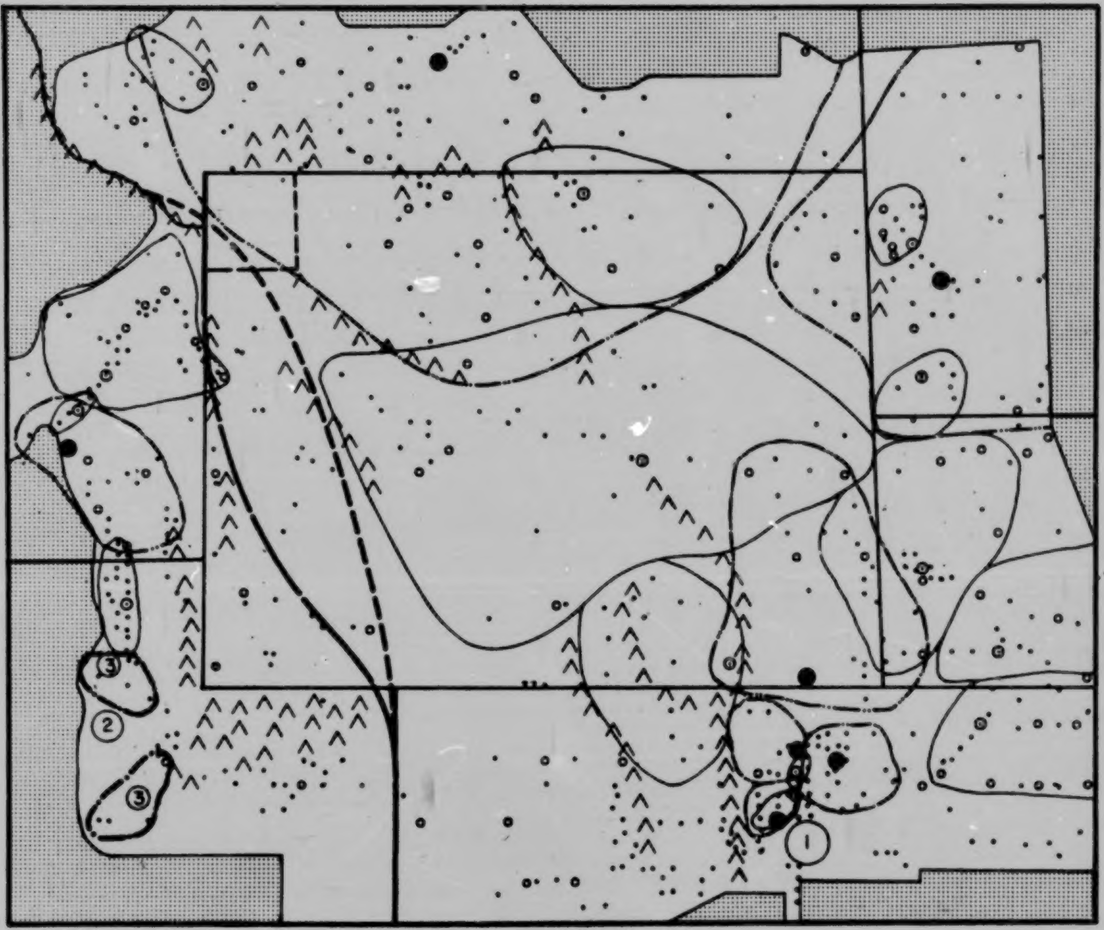

FIGURE V-1
MAP OF THE STUDY REGION ILLUSTRATING THE ESTIMATED HEALTH SERVICE AREAS

LEGEND

CITIES IN:

- ① - GROUP 1
- ② - GROUP 2
- ③ - GROUP 3
- ● - GROUP 4
- ⊙ - GROUP 5
- ∘ - GROUP 6
- · - GROUP 7
- ⋀ - MOUNTAINS

BOUNDARIES AROUND:

- — — - GROUP 1
- - - - - GROUP 2
- —·—·— - GROUP 3
- -·-·-·- - GROUP 4
- ——— - GROUP 5
- ——— - STATES

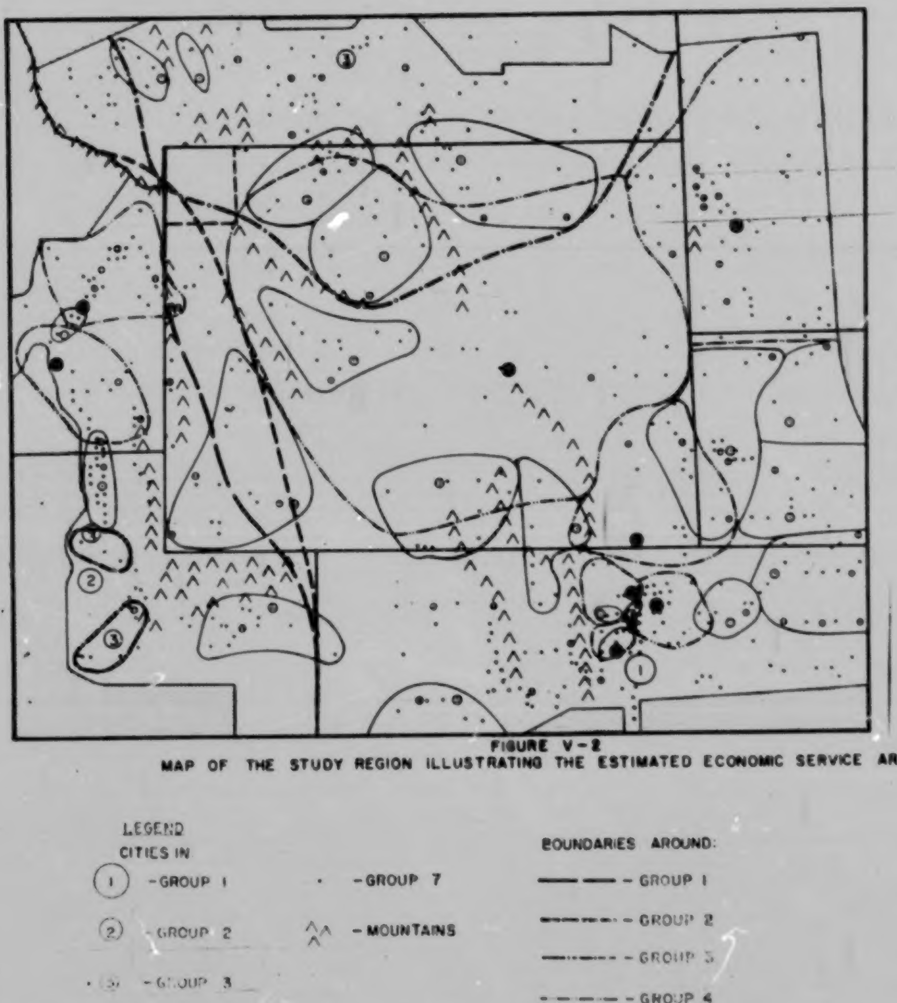

FIGURE V-2
MAP OF THE STUDY REGION ILLUSTRATING THE ESTIMATED ECONOMIC SERVICE AREAS

LEGEND
CITIES IN

① -GROUP 1
② -GROUP 2
③ -GROUP 3
● -GROUP 4
◎ -GROUP 5
∘ -GROUP 6
· -GROUP 7
^^ -MOUNTAINS

BOUNDARIES AROUND:

——— -GROUP 1
—·—·— -GROUP 2
—··—·· -GROUP 3
-·-·- -GROUP 4
——— -GROUP 5
——— -STATES

economic system, if the average number of businesses in some group is less than two for some retail economic activity i, then the activity is assumed to be absent due to the lack of competition for that activity. Since the health system is regulated in various ways, competition in the health-care delivery system differs considerably from the economic system. Thus, the operational rule quoted in Chapter IV is not applicable. Rather, the operational rule adopted for the health-care delivery system is that the health-care activity or health-care personnel were considered to be absent if the average number was less than one.

D. ANALYSIS OF INTER-GROUP MARGINAL HEALTH-CARE DIFFERENCES

In this section, there is a development of a theoretical framework paralleling the inter-group theoretical framework of the economic system (Chapter IV). The proposal is that inferences can be made that permit inter-group differentiation on the basis of the presence or absence of health-care activities.

The basis of the differentiation was the expectation that communities have different orderings of health-care services. Some have extensive and highly specialized facilities and manpower, while other communities will have less extensive and less specialized facilities and manpower. Drawing upon central place theory, two assumptions are relevant. First, communities can be ordered. Second, some health-care activities are of a higher-order than others; and for any inter-group movement there exist "hierarchical marginal health-care activities."

In Chapter IV an explanation accompanied the propositions used to identify the "hierarchical marginal goods and services." In this chapter, the following propositions parallel those in Chapter IV; and therefore, no accompanying explanation is included in view of the earlier discussion.

1. The Ordering of Health-Care Activities

Any set of health-care activities can be arranged from the highest-order of health-care activity to the lowest-order of health-care activity.

2. Inter-Group Marginal Health-Care Activities

Given a hierarchical health-care system, the entire set of health-care activities is found in central places belonging to the highest-order group. For movement down the hierarchical system from group to group, the order and magnitude of health-care activities performed become less for each group.

3. Magnitude of Inter-Group Health-Care Activities

If the members of any two groups in a hierarchical health system perform the same order activities, then the magnitude of the activities performed by the members of the higher-order group will be greater than the magnitude of the activities performed by the lower-order group.

4. Necessary and Sufficient Conditions for Inter-Group Movement

For any inter-group movement, the set of health-care activities necessarily changes (i.e., that inter-group marginal health-care differences exist for the two groups), and the magnitude of health-care activities changes sufficiently (i.e., increases or decreases in the number of health manpower and the extent of health-care facilities).

In addition to the propositions stated above, two operational criteria were adopted.

Criterion 1

If the average number of the individual health variables of some cell i (vector) for some group j is less than unity, then it is assumed the variable is absent in the cell and a value of zero is substituted for that variable.

Criterion 2

If, for some activity set of group j, more than half of the variables in the set are absent, then the activity set is assumed to be absent.

Table V-1 lists the 24 variables used to identify the health-care system. The variables are divided into six different activity sets. Activity set six includes a single variable, occupancy rate, computed for those communities that have a hospital. In this sense, activity set H_6 is not a pure average across all communities in Group 7, but an average for those communities that have a hospital (sixteen hospitals in 440 communities).

Table V-1 can be represented by Table V-2 after the application of Criterion 1: a zero is substituted for each variable in Table V-1 for which the average of that variable is less than unity. Table V-3 is

TABLE V-1

AVERAGE NUMBER OF HEALTH MANPOWER OR HEALTH FACILITIES BY SETS OF HEALTH ACTIVITIES AND THE SEVEN GROUPS

Sets of Health Activities	HIERARCHICAL GROUPS						
	G_1	G_2	G_3	G_4	G_5	G_6	G_7
H_1 -- Hospital Facilities							
Radiology dept.	45.0	12.0	3.7	2.9	.9	.0	.0
Heart surgery & histopathology lab.	23.0	12.0	2.7	1.6	.4	.1	.0
X-Ray therapy	11.0	5.0	1.0	1.4	.4	.0	.0
Renal dialysis	17.0	6.0	.3	.5	.0	.0	.0
Health Manpower							
Podiatrist	42.0	19.0	3.7	2.3	.4	.0	.0
H_2 -- Hospital Facilities							
Inhalation therapy	19.0	9.0	2.7	1.9	.8	.2	.0
Pharmacist, full-time	21.0	10.0	3.0	2.6	.8	.0	.0
Rehabilitation facilities	49.0	15.0	4.0	1.4	.6	.2	.0
Health Manpower							
Optometrists	107.0	29.0	10.7	7.3	2.9	.7	.0
Phys. therapists	277.0	57.0	10.0	8.1	1.4	.2	.0
H_3 -- Nursing Homes and Hospitals							
Number of nursing homes	113.0	77.0	12.7	4.5	1.5	.9	.1
Number of hospitals	29.0	11.0	3.0	2.5	1.0	.8	.0
Health Facilities							
Emergency dept.	19.0	9.0	2.3	2.3	.8	.7	.0
Health Manpower							
Dental hygienist	293.0	14.0	7.7	10.9	1.5	.4	.0
H_4 -- Nursing Homes & Hospitals							
Number of hospital beds	7660.0	2492.0	634.3	336.1	112.3	46.1	.9
Health Manpower							
Active LPN's	2472.0	1115.0	285.0	89.9	29.0	7.1	.8
Pharmacists	983.0	397.0	79.0	48.6	13.0	4.5	.4
D.O.'s & M.D.'s	2798.0	1006.0	133.7	73.5	15.6	3.6	.2
Dentists	735.0	475.0	81.0	36.6	10.0	2.2	.1
Veterinarians	197.0	35.0	17.0	21.6	5.5	1.7	.2
H_5 -- Nursing Homes & Hospitals							
Number of nursing home beds	8300.0	2651.0	789.3	331.2	110.9	37.6	1.3
Health Manpower							
Active R.N.'s	7160.0	2531.0	684.7	336.0	74.9	19.3	2.0
Number of hospital personnel	20,145.0	6301.0	1178.7	644.1	163.1	54.1	1.5
H_6 -- Nursing Homes & Hospitals							
Number of nurs. home beds	77.0	83.0	77.7	66.8	56.1	48.5	45.9

TABLE V-2

AVERAGE NUMBER OF HEALTH MANPOWER OR HEALTH FACILITIES BY SETS OF HEALTH ACTIVITIES AND SEVEN GROUPS, CORRECTED FOR CRITERION 1

Sets of Health Activities	HIERARCHICAL GROUPS						
	G_1	G_2	G_3	G_4	G_5	G_6	G_7
H_1 -- Hospital Facilities							
Radiology dept.	45.0	12.0	3.7	2.9	0.0	0.0	0.0
Heart surgery & histopathology lab.	23.0	12.0	2.7	1.6	0.0	0.0	0.0
X-Ray therapy	11.0	5.0	1.0	1.4	0.0	0.0	0.0
Renal dialysis	17.0	6.0	0.0	0.0	0.0	0.0	0.0
Health Manpower							
Podiatrist	42.0	19.0	3.7	2.3	0.0	0.0	0.0
H_2 -- Hospital Facilities							
Inhalation therapy	19.0	9.0	2.7	1.9	0.0	0.0	0.0
Pharmacist, full-time	21.0	10.0	3.0	2.6	0.0	0.0	0.0
Rehabilitation facilities	49.0	15.0	4.0	1.4	0.0	0.0	0.0
Health Manpower							
Optometrists	107.0	39.0	10.7	7.3	2.9	0.0	0.0
Phys. therapists	277.0	57.0	10.0	8.1	1.4	0.0	0.0
H_3 -- Nursing Homes and Hospitals							
Number of nursing homes	113.0	77.0	12.7	4.5	1.5	0.0	0.0
Number of hospitals	29.0	11.0	3.0	2.5	1.0	0.0	0.0
Health Facilities							
Emergency dept.	19.0	9.0	2.3	2.3	0.0	0.0	0.0
Health Manpower							
Dental hygienist	293.0	14.0	7.7	10.9	1.5	0.0	0.0
H_4 -- Nursing Homes & Hospitals							
Number of hospital beds	7660.0	2492.0	634.3	336.1	112.3	46.1	.0
Health Manpower							
Active LPN's	2472.0	1115.0	285.0	89.9	29.0	7.1	.0
Pharmacists	983.0	397.0	79.0	48.6	13.0	4.5	.0
D.O.'s & M.D.'s	2798.0	1006.0	133.7	73.5	15.6	3.6	.0
Dentists	735.0	475.0	81.0	36.6	10.0	2.2	.0
Veterinarians	197.0	35.0	17.0	21.6	5.5	1.7	.0
H_5 -- Nursing Homes & Hospitals							
Number of nursing home beds	8300.0	2651.0	789.3	331.2	110.9	37.6	1.3
Health Manpower							
Active R.N.'s	7160.0	2531.0	684.7	336.0	74.9	19.3	2.0
Number of hospital personnel	20,145.0	6301.0	1178.7	644.1	163.1	54.1	1.5
H_6 -- Nursing Homes & Hospitals							
Number of nurs. home beds	77.0	83.0	77.7	66.8	56.1	48.5	45.9

derived from Table V-2 by the application of Criterion 2. That is, a zero is substituted for activity sets H_1 through H_5, when the number of zeros in an activity set for any group is less than 50%.

Given Table V-3, it is possible to identify the inter-group marginal health-care activities for the rural groups in the health-care system (i.e., Groups 4 through 7).

From Table V-3 the inference is that activity set H_4 is the intermarginal activity set between Groups 6 and 7. The set H_4 includes the following:

a. number of hospital beds;
b. number of active L.P.N.'s;
c. number of pharmacists;
d. number of osteopaths and medical doctors;
e. number of dentists; and
f. number of veterinarians.

From Table V-3, it is inferred that activity sets H_2 and H_3 are the inter-group marginal activity sets that permit a distinction between Groups 5 and 6. The set H_2 includes the following:

a. number of optometrists;
b. number of physical therapists;
c. number of inhalation therapy facilities;
d. number of full-time pharmacists in hospitals; and
e. number of rehabilitation departments in hospitals.

The set H_3 includes the following:

a. number of nursing homes;
b. number of hospitals;

TABLE V-3

INTERGROUP MARGINAL HEALTH-CARE ACTIVITIES

Sets of Health Activities	Hierarchical Groups G_1	G_2	G_3	G_4	G_5	G_6	G_7
H_1	P	P	P	P			
H_2	P	P	P	P	P		
H_3	P	P	P	P	P		
H_4	P	P	P	P	P	P	
H_5	P	P	P	P	P	P	P
H_6	P	P	P	P	P	P	P

P = activity present

c. number of emergency departments in hospitals; and

d. number of dental hygienists.

From Table V-3 the inference is that activity set H_1 is the inter-group marginal activity set that permits a distinction between Groups 4 and 5. The set H_1 includes the following:

a. number of radiology departments in hospitals;

b. number of heart surgery facilities and histopathology laboratories;

c. number of X-ray therapy departments in hospitals;

d. number of renal dialysis facilities in hospitals; and

e. number of podiatrists.

E. CONCLUSION

This chapter has shown that the methodology applied to the economic system in earlier chapters of the study is equally applicable to the health-care delivery system. A seven-group hierarchy has been formed and described; and sets of marginal activities identified--the results of which are essentially equivalent to those of the economic system of Chapter IV. Consequently, the strengths and weaknesses noted with respect to identification of the economic system also apply to the identification of the health system in this chapter.

Another conclusion made in addition to the methodological, is the difficulty in obtaining accurate and reliable health data. This aspect of the study has been exasperating and has emphasized the significance of using economic data, which are more readily available, in place of health data for health planning purposes.

CHAPTER VI

COMPARISON OF THE ECONOMIC SYSTEM WITH THE HEALTH-CARE DELIVERY SYSTEM

In previous chapters, there has been a development of an empirical methodology and the application of that methodology to the formation of economic and health-care hierarchical systems. A most important step in the analysis was the comparison of the economic system with the health-care delivery system. Only if there is a close relationship can the economic system and economic data be used as surrogates for the health-care delivery system and health data. It is the purpose of this chapter to consider the relationship of the two systems.

In Section A of the chapter there is a comparison of the economic and health-care hierarchies. Section B is a description of the rationale and methods employed in statistical comparison of the systems. Section C is the statistical comparison.

A. GENERAL COMPARISON

Since the economic hierarchy was formed by first using 74 variables and again by using 17 variables, a brief comparison has been made between these two results and the health hierarchy.

As a generalization, the 74-variable system and the 17-variable system are much alike. The number of communities in each of the hierarchical groups is identical through the first five groups and differs by five communities in groups six and seven. Moreover, for the top five groups there are only two communities for which the grouping differs, and these are at the bottom of G_5. Differences in the ranking of places do not occur until G_4.

In comparing the health hierarchy with the 74-variable economic system (see Appendices C and D), the major generalization is that the first four groups in the economic hierarchy have more communities than the health hierarchy. The economic hierarchy contains the following numbers of communities in each of the top five groups: 1, 1, 3, 8, 21. The corresponding numbers for the health hierarchy are 1, 1, 2, 7, 14. Consequently, there is a tendency for places to drop in the health grouping as compared to the economic grouping. For example, Billings slips from G_3 to G_4, Idaho Falls from G_4 to G_5, and Cody from G_5 to G_6. Except for inter-group movements, the two hierarchies appear to be much alike.

There is no apparent reason for the tendency of places to drop in the health grouping. However, there are a couple of possibilities for the trend. First, it is possible that the health system is not as well developed as the economic system for the communities with a population base below 100,000.

Secondly, the health-care delivery system may be subject to considerable agglomeration. If such is the case, efforts to decentralize the health-care delivery system may fail unless a clearer understanding is obtained of the trend for agglomeration to occur. For example, the movement of Casper to a lower health grouping may be a reflection of the fact that a viable health-care delivery system may require a much larger base of population and economic activity before agglomeration will occur. Again, this is an untested hypothesis that would require empirical testing.

B. METHOD OF STATISTICAL COMPARISON

The health-care delivery system is a subset of the economic system and can be hierarchically ordered in a way similar to the economic system. A hypothesis arises, namely, that there should be statistical correspondence between the empirically derived health and economic hierarchies. Further, it should be possible to show statistical significance in the functional relationship between the health and economic systems.

To test the similarity of the two systems, statistical measurements for the systems were derived. The methodology employed in delineating the hierarchies in this study was developed through use of an economic centrality index, C_j, and an index of health services, HC_j, for each of the 538 places in the study region. This process yielded two lists containing all places: one ranked places by an economic centrality index and the other ranked them by the health service index. These two rankings were tested for similarity by use of non-parametric techniques--the Spearman rank-correlation coefficient and the Kendall rank-correlation coefficient. (The non-parametric tests were used since the assumption of a normal population distribution is not required.)

Because of the assumption that the health-care delivery system is a function of the economic system, parametric tests were performed. The parameters for a linear regression of the following form were estimated and submitted to standard parametric tests:

$$HC_j = a + bC_j$$

where

a,b = parameters.

C. RESULTS OF THE STATISTICAL TESTS

Both the non-parametric and parametric statistical tests confirmed the hypothesis that the health hierarchy and the economic hierarchy are similar. The 74-variable economic hierarchy was first compared with the health hierarchy; then, the 17-variable economic hierarchy and the health hierarchy were compared.

The non-parametric tests comparing the 74-variable economic hierarchy and the 24-variable health hierarchy tested the hypothesis:

$$HC(24)_j \neq C(74)_j.$$

For both the Spearman rank-correlation and the Kendall rank-correlation coefficient, there was a probability of 0.999 that the hypothesis was incorrect. That is, by the use of the tests, the hypothesis of the inequality of the 74-variable economic hierarchy and the health hierarchy was rejected.

The regression model for these two hierarchies yielded the following results:

$$HC(24)_j = 0.03596 + \underset{(0.001687)}{2.17616}\, C(74)_j \qquad R^2 = 0.97 \quad F = 16646.4$$

The number in parentheses (0.001687) is the standard error. The standard error is a measure of the scatter of the lines about the regression line. As the value of the standard error approaches the value of the slope (i.e., 2.17616), the slope coefficient becomes less reliable as a predictor. In this case, the standard error was quite small with respect to the slope coefficient, hence the coefficient was a dependable predictor.

The coefficient of multiple determination, R^2, is a statistic measuring the variance in $HC(24)_j$ that is explained by $C(74)_j$. In the above regression model, 97% of the variance in the health-care delivery system is explained by the economic system. Finally, the F-statistic is a statistical test used to determine whether the slope coefficient is significantly different from zero. For all values of F greater than 6.63 (i.e., the 1% confidence level), the slope coefficient is non-zero. In the above regression the observed F-value of 16646.4 is considerably greater than 6.63.

In view of the small standard error of estimate, the large R^2, and the large observed F-value, the following conclusion was reached: the hypothesis that the economic and health systems are the same has been statistically accepted at the 1% level of significance for the 74-variable economic system and the 24-variable health-care system in the intermountain study region.

An identical set of tests was performed comparing the 17-variable economic system and the 24-variable health system. The non-parametric test results were almost identical to those for the above comparisons: the probability was 0.999 that the systems were related. The results of the regression model were as follows:

$$HC(24)_j = 0.00526 + \underset{(0.00526)}{0.56541}\, C(17)_j \qquad \begin{array}{l} R^2 = 0.97 \\ F = 17519.2 \end{array}$$

For this regression the observations are that: (1) the standard error is quite small compared to the slope coefficient, (2) the R^2 indicates that 97% of the variance in the health system was explained by the 17-variable economic system, and (3) the observed F-value is considerably greater than the theoretical F-value of 6.63.

D. CONCLUSION

The statistical tests discussed in this chapter suggest that both the 74-variable and the 17-variable economic systems are closely related to the

24-variable health-care delivery system. Moreover, since the comparisons showed that the 17-variable system is equally similar to the health system as the 74-variable economic system, there is strong evidence for the intermountain study region that would justify the use of the 17-variable economic system as a surrogate for health planning.

The generalized discussion comparing the groups in the health hierarchy with the groups in the economic hierarchy leads to the conclusion that the statistical tests may have masked some fundamental differences between the two systems. The health service indexes decrease more rapidly for ranked places than do the economic centrality indexes, and the progression of central places in the middle groups of the hierarchy is much lower for the health system. This comparison may reflect a lag in the development of the health system as compared to the development of the economic system. That is, the development of the economic system is a necessary condition for the development of the health system. Thus, the development of the health system will lag behind and be dependent upon the economic system.

The authors would argue that the discussion in this chapter indicates there are some reservations about the relationship of the economic system to the health system. Nevertheless, the statistical results have demonstrated a close relationship between these systems in the intermountain region.

CHAPTER VII

HEALTH MANPOWER EDUCATION

Thus far, two hierarchies have been developed, one having been derived from the economic system and the other from the health delivery system. These two hierarchies are reflective of the interdependence of rural communities and larger cities for economic and health purposes. The objective of this chapter is to relate the concept of hierarchical demand structures to the location of existing health manpower education programs.

In the first section, the scope of the analysis is defined and the data sources are identified. The second section is an attempt to determine the applicability of hierarchical demand structures to educational and health planning. The discussion concerns the problem of locating a health manpower program such that there is sufficient utilization of the program (demand), and/or such that the program has a specified impact on the health delivery system. The third section is an identification of the criteria existing in the study region for the initiation and location of health manpower education programs. Included in the following section is a general evaluation of the criteria. The last section is a summary of Chapter VII and conclusions reached.

A. DATA SOURCES

The scarcity of data limited the analysis of the health manpower education system in the region. This was especially apparent in the case of informal education. Estimations are that over 50% of the education in the health field is on-the-job training. However, secondary data about on-the-job training are nonexistent. The scope and objective of this study did not warrant the time and financial resources to develop the necessary data on which to base an analysis of on-the-job training. Through conversations with individuals in the health and education fields, it was revealed that data were unavailable, and that on-the-job training was not identified as an educational program. Lack of data necessitated narrowing the scope of the analysis to formal health manpower education.

Data on formal allied health education were partially obtained from the Bureau of Health Manpower Education publications, Allied Health Education Programs in Junior Colleges/1970 and Allied Health Education Programs in Senior Colleges/1971.

Nursing programs located in hospitals or senior colleges were not included in the BHME publications. In order to obtain a more comprehensive listing of nursing programs, the state nursing boards in the region were contacted and asked to identify all approved nursing programs in their states. Institutions having approved nursing programs, but not included in the publications, were then contacted to eliminate the missing information. (See Appendix E for a tabulation of programs and selected data.)

Also omitted from these two data sources were programs for physicians, dentists, and pharmacists. There are no schools of dentistry in the study region. College catalogues were consulted to obtain some data for pharmacy programs. Pharmacy schools were then contacted to complete the set of information. Data for the region's two medical schools were obtained from The Journal of the American Medical Association.

Educational institutions in the region were asked to provide information regarding the geographic location of graduates for the past decade or since origin, whichever was the shorter period. Most responses were negative, no information. Of the positive responses, the majority provided only a rough estimate of the percentage of graduates remaining in the city or geographic area where educated. In only a very few cases were data provided as to how each graduating class was distributed with respect to cities.

B. THE DEMAND FOR EDUCATION AND SUPPLY OF HEALTH MANPOWER

The objective of health manpower education programs is either to increase or to maintain an adequate supply of health manpower within a region. In order to achieve this objective two points are considered. First, a program must be located such that there is a demand for it. That is, there must be a sufficient number of students enrolled in the program. Secondly, there must be a dispersion of program graduates such that a percentage remains in the region, and thereby, has a positive or neutral impact on the health delivery system.

1. Demand for Education

The demand for a particular educational program is a demand for an investment good. The decision to invest in human capital will, like other investment decisions, depend on the rate of return or profitability (see Becker, 1964). The rate of return is determined by an individual's evaluation of the discounted expected income flow resulting from his decision to invest in education, and by his estimation of the cost of obtaining that education. A discounting factor for uncertainty and risk may enter the decision. Psychic and social factors also influence decisions.

With a few modifications, a point on a demand curve for an educational program in an institution can be estimated as the summation of all the individual decisions to enroll in that program at a specified price. If an enrollment ceiling exists fixing the quantity provided at a given price at a level below what would be demanded at that price, then enrollment does not reflect the demand at that price. A more accurate estimate of demand could be obtained by relating the number of applicants, enrollment figures, and the institution's estimation of enrollment capacity at a point in time.

The derivation of a demand curve for an educational program is a difficult task. A demand curve is a schedule of the quantity of a good that will be purchased at various price levels. Through the buying process, consumer preferences are revealed. Since public education is a public good highly subsidized by the government, market interference by the government does not permit revelation of consumer preferences.

The education costs to students include both direct and indirect costs. Students pay only a small portion of the direct costs of their education. This could be one explanation for the bias in the American society for formal education. Students involved in on-the-job training pay part of the direct cost of their education by acceptance of a lower, trainee wage, while also paying a portion of the costs of formal education by contributing to the tax structure. In contrast, students enrolled in formal education programs pay a portion of the direct cost of their education and during the interim, contribute less to the tax structure. Further, formal education participants have access to such additional benefits as scholarships, veteran's benefits, and student loans not available to on-the-job trainees.

In formal education, each college quotes a fixed amount of tuition for resident students, whether enrollment is in a curriculum requiring expensive laboratory facilities, or in a less costly curriculum. Therefore, that tuition may not reflect the total or relative cost of producing that good. The price of one program is not allowed to vary according to changes in the market situation. Instead, the price of all programs in an institution changes by the same amount over time.

Political boundaries place a greater restriction on the demand for education than on the demand for other goods and services. Attendance at a public institution of higher education in a state other than the state of residence results in higher tuition costs to the student. For example, residents of Wyoming encounter few restraints when trading in Colorado. However, if a Wyoming resident chooses to attend a public college in Colorado, he must pay the more costly out-of-state tuition.

2. Demand for Education - Inferences from Hierarchical Demand Structures

Recalling central place theory, there are higher-order and lower-order central places. The higher-order centers offer all of the services offered by lower-order centers plus some additional, more specialized services. These more specialized services are referred to as higher-order goods, while the more general services found in almost every city are termed lower-order goods and services.

When the education system is analyzed in terms of hierarchical demand structures, it must be determined which educational programs are of higher-order requiring a large market area, and which programs are of lower-order serving a small market area. An educational hierarchy was not developed to ascertain this. Not only were the data inappropriate and too inconsistent to establish an educational hierarchy, but such a hierarchy would not be meaningful or operational. An educational hierarchy would reflect the present degree of education concentration in communities, and therefore does not assist in making locational decisions for health education. Inferences are made by comparing existing programs and their characteristics with the indices of the community in the economic and health hierarchies.

Table VII-I lists cities according to the magnitude of their economic index. Horizontally, "x" is inserted if the city has one or more of a specified program. Highest-order programs will exist in cities high in the ranking order, while lower-order programs will exist both in cities with high indices and in some communities with low indices. It follows that cities in upper groups will have more programs than those in a lower group. There is some threshold, as measured by the indices, below which the location of certain health education programs is not feasible.

If the cities are denoted i and the programs j, then the total number of cities having program type j is $\sum_i E_{ij}$, where E_{ij} is program j in community i. The number of different types of programs in city i is $\sum_j E_{ij}$. It is expected that when $[C_i > C_{\bar{i}}]$ then $[\sum_j E_{ij} > \sum_j E_{\bar{i}j}]$ and when $[C_i < C_{\bar{i}}]$ then $[\sum_j E_{ij} < \sum_j E_{\bar{i}j}]$. If enrollment is taken as a proxy for size, then it is expected that when $[C_i > C_{\bar{i}}]$ then $[N_{ij} > N_{\bar{i}j}]$, where N_{ij} is the number of students enrolled in program j in city i.

Statistical tests were not run, but the data from Appendix F do imply that when $[C_i > C_{\bar{i}}]$ then $[\sum_j E_{ij} > \sum_j E_{\bar{i}j}]$, which leads to a possible relationship $[\sum_j E_{ij} = f(C_i)]$. A similar inference can be drawn from $[\sum_j E_{ij} = f(HI_i)]$,

TABLE VII-1

COMMUNITIES HAVING ONE OR MORE HEALTH MANPOWER EDUCATION PROGRAMS

		Pop.	Econ. Index	Health Index	Bio Med Eng.	Child Hlth Assoc	Dent Asst	Dent Hyg	Dent Lab Techni	Diet/Nutri	Enviro Hlth Spec	Envior Techni	Hlth Educator	Hlth Adm Asst	Hlth Serv Asst	Inhal Ther	Lab Asst	LPN	Med Off Asst	Med Techni	Ment Hlth Asst	Nucl Med Techni	Occup Ther	Phys Ther	Radio Hlth Spec	Radio Hlth Techni	Radio Techni	Radio Ther Techni	Rec Ther	Rehab Coun	Sp Path/Audio	Surg Techni	RN	Pharmacy	Med School
DENVER	C	999999	5.00124	9.39779	-	X	X	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	-	X	-	-	X	X	-	-	X	X	X	X	X
SALTLAKE C	U	557635	2.62146	3.13791	-	-	-	-	-	X	-	-	-	-	-	-	-	X	-	X	-	-	-	X	-	-	X	-	-	-	X	-	X	X	X
BILLINGS	M	61581	.58468	.57462	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	X	-	-	-	X	-	-	-	-	-	X	-	-	-	-	-
OGDEN	U	116945	.57777	.71329	-	-	-	-	-	-	-	-	-	-	-	X	-	X	-	X	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-
PROVO	U	119451	.51670	.83878	-	-	X	-	-	X	-	-	X	-	-			X		X	-	-	-	-	-	-	-	-	X	-	-	-	X	-	-
CASPER	W	39400	.38948	.31268	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
BOULDER	C	69279	.38691	.58074	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
RAPID CITY	S	43836	.34894	.56438	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
IDAHOFALLS	I	35776	.31194	.35620	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
POCATELLO	I	40036	.29437	.52280	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	X	-	X	X	-
FT COLLINS	C	43337	.28988	.47981	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	X	-	-	X	-	X	-	-	-	-	-	X	-	-	-	-
GREELEY	C	40129	.27060	.42652	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	X	-	X	-	-
CHEYENNE	W	40000	.26298	.55235	-	-	-	-	-	-	-	X	-	X	-	-	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	X	-	-	-
LONGMONT	C	23209	.18337	.25059																															
SCOTTSBULF	N	14507	.17120	.31606	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
BOZEMAN	M	18670	.16624	.23605	-	-	-	-	-	X	X	-	-	-	-	-	-	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
LOGAN	U	22333	.14410	.19428	-	-	-	-	-	X	X	-	X	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
LOVELAND	C	16220	.12659	.18158																															
LARAMIE	W	24700	.12409	.17472	X	-	-	-	-	X	-	-	-	-	-	-	-	X	-	X	-	-	-	-	-	-	-	-	-	-	X	-	X	X	-
SHERIDAN	W	10800	.11345	.22785	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
STERLING	C	10636	.09815	.22727	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ROCK SPGS	W	12100	.09542	.13081																															
GLENWOODSP	C	4106	.08734	.07277																															
ALLIANCE	N	6862	.08287	.01784	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FT MORGAN	C	7594	.08064	.07445																															
VERNAL	U	3908	.07614	.01814																															
BLACKFOOT	I	8716	.07489	.18774																															
RIVERTON	W	7995	.07464	.06486																															
ESTES PARK	C	1616	.07067	.02331																															
LIVINGSTON	M	6883	.06790	.07497																															
RAWLINS	W	7855	.06767	.09185																															
SIDNEY	N	6403	.06563	.15461																															
CODY	W	5161	.06557	.09115																															
WORLAND	W	5055	.06283	.08652																															
REXBURG	I	8272	.05740	.05477	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
BELLEFCHE	S	4236	.05631	.07819																															
EVANSTON	W	4462	.05334	.12269																															
POWELL	W	4807	.05254	.05182																															
DEADWOOD	S	2409	.05208	.06822																															
CRAIG	C	4205	.05160	.05885																															
CHADRON	N	5921	.05100	.06143	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-
TORRINGTON	W	4237	.04911	.07786																															
LANDER	W	7125	.04806	.08383																															
GILLETTE	W	7194	.04763	.07065																															
STURGIS	S	4536	.04706	.19311																															
JACKSON	W	3196	.04656	.04074																															
BRUSH	C	3377	.04418	.05729																															
:	:	:	:	:																															
KIMBLE	N	3680	.04347	.03639																															
PRESTON	I	3310	.04182	.02266																															
GREENRIVER	W	4196	.04118	.00465																															
GERING	N	5639	.04093	.03579																															
MONTPELIER	I	2604	.04054	.00911																															
GORDAN	N	2106	.03824	.04775																															
HOT SPRINGS	S	4434	.03712	.15712																															
ROOSEVELT	U	2005	.03618	.03837																															
SPEARFISH	S	4661	.03604	.06415	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
:	:	:	:	:																															
RANGELY	C	1591	.01003	.02690	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

where HI_i is the health index in community i. However, statistical problems are present since $\sum_j E_{ij} = f(HI_i)$, and $[HI_i = f(E_{ij})]$.

In order to determine if there are higher-order and lower-order health education programs, Table VII-2 was developed to identify the rank of the economic index for cities offering each type of program. According to central place theory, higher-order places have all the services offered in lower-order cities plus more specialized services. If the magnitude of the economic index is taken as a measure of order, then there should be some order of programs. Specialized programs exist in the higher-order cities, while more general programs are found in both the higher-order and the lower-order cities. Using Appendix E and Table VII-1 there does appear to be some sort of pattern or order. The range of the economic index for cities having certain programs is greater than the range for cities having other programs. For example, for medical technologists the range is 5.00124 to .03604, for medical schools it is 5.00124 to 2.62146. The wider the range, the more general is the program. Where a program is located in only one city, the order of the program might be indicated by the economic index of that city.

Reasons exist why more specialized programs are located in cities with high economic indices. First, specialized programs must have a larger market area, as is indicated by the magnitude of the indices. Secondly, higher indices reflect a more extensive health complex (i.e., greater demand) and economic base to support such education.

To analyze the demand for an education program, it is necessary to identify not only its existence in a community, but also some measure of the quantity purchased. Enrollment figures for programs have been used to approximate demand. For a given type of program j, the expectation is that

TABLE VII-2

RANGE OF ECONOMIC INDEX AND HEALTH INDEX FOR COMMUNITIES HAVING HEALTH MANPOWER EDUCATION PROGRAMS

Program	Econ Index Range	Health Index Range
Bio Med Eng	.12409	.17472
Bio Med Eng Techni	5.00124	9.39779
Child Hlth Assoc	5.00124	9.39779
Dental Assistant	5.00124-.01003	9.39779-.02690
Dental Hygienist	.29437-.01003	.52280-.02690
Dental Lab Techni	.11345	
Diet/Nutri	2.62146-.12409	3.13791-.17472
Enviro Hlth Spec	.28988-.14410	.47981-.19428
Health Educator	.51670-.14410	.83878-.19428
Hlth Adm Asst	.26298	.55235
Hlth Serv Asst	5.00124	9.39779
Inhal Therapist	5.00124	9.39779
Lab Asst	5.00124-.26298	9.39779-.55235
Licensed Practical Nurse	5.00124-.82787	9.39779-.10784
Med Off Asst	5.00124	9.39779
Medical Techno	5.00124-.03604	9.39779-.06415
Nuclear Med Techni	5.00124	9.39779
Occup Therapist	.28988	.47981
Pharmacy	5.00124-.12409	9.39779-.17472
Physical Therapist	5.00124-.05100	9.39779-.06143
Physician	5.00124-2.62146	9.39779-3.13791
Radio Hlth Spec	.28988	.47981
Radio Hlth Techni	.29437	.52280
Radio Techni	5.00124-.26298	9.39779-.55235
Radio Ther Techni	5.00124	9.39779
Recreation Therapist	.51670	.83878
Registered Nurse	5.00124-.05740	9.39779-.05477
Rehab Consu	.58468	.57462
Speech Path/Audio	5.00124-.12409	9.39779-.17472
Surg Techni	5.00124-.26298	9.39779-.55235

the enrollment in program j in community i, N_{ij}, is greater as the level of economic activity in community i is greater. That is, when $[C_i > C_{\bar{i}}]$ then $[N_{ij} > N_{\bar{i}j}]$. This comparison can be made only in the context of one degree level. Enrollment figures for advanced degree programs were differentiated from those of lower degrees. Enrollment figures for each degree of each program were ordered according to the economic hierarchy. Inadequate observations within each training category have prohibited meaningful inferences. However, for a given program offering a particular degree, a tendency exists for $[N_{ij} > N_{\bar{i}j}]$ when $[C_i > C_{\bar{i}}]$ and there may be a positive relationship $[N_{ij} = f(C_i)]$.

There appears to be a positive relationship $[N_{ij} = f(O_{ij})]$, where O_{ij} is the date of first enrollment in program j in community i. Due to the process of economic development, educational programs in cities with a high level of economic activity were established before programs in the less developed communities, implying that $[O_{ij} = f(C_i)]$. Another reason for the relationship $[N_{ij} = f(O_{ij})]$ is the general policy of starting with a smaller program and expanding according to the success of the program.

In moving from cities in Groups 1 and 2 to cities in lower-order groups, a smaller percentage of the variation in $\sum_j E_{ij}$ is explained by C_i. As C_i decreases in value, it is probable that the number of health education programs is more a function of the existence and size of educational institutions, rather than of the level of economic activity. By locating several health manpower education programs at one institution, agglomeration economies occur. Economies of scale may develop with respect to each program. That is, as output increases, the unit cost of production decreases. Due to agglomeration economies and economies of scale, health manpower education programs cluster at existing institutions. Since the decisions to establish health education programs are usually made singly, once an educational institution is established, programs tend to locate at that institution. Therefore, the expectation should not be that individual health manpower education programs have been optimally located in the past.

In summary, the number of educational programs in a community is a function not only of the level of economic activity, but also of the existence of junior and senior colleges. Due to governmental interference, the educational market does not respond to the same stimuli as private enterprise. Private enterprise must locate and conduct business in a rational manner or the market system does not allow a profit. Education, however, is a highly subsidized industry. Locational and financial matters are determined via the political process.

3. Supply of Health Manpower

A distinction is made between the long-run and short-run supply of manpower.

> In the short-run, the supply of a particular type of labor depends upon the responsiveness of persons already trained or experienced in that field to changes in wages and other factors. No new workers can be produced in the short-run. The long-run, on the other hand, is defined as a sufficient period of time for qualified persons both to decide they want to work in a certain occupation, and to get whatever training is necessary. (Donald Yett, 1965).

Education, then, is a means to alter the long-run supply of manpower. The length of the long-run period varies according to the occupation. Efforts in health manpower education are directed to increasing the long-run supply of a particular type of labor. However, changing the elasticity of supply and/or the productivity of labor could also be a useful tool.

Elasticity refers to the responsiveness of skilled persons to changes in wages. If wages change by 10% while the quantity of man-hours offered changes by only 5%, supply is said to be inelastic. Should wages change by 10% and the quantity of man-hours offered changed by 15%, supply is considered elastic.

One way in which education can alter the elasticity of supply is by the development of a core curriculum in health manpower education. Individuals would be able to change from one health occupation to another with a minimum of additional education. By expanding the number of alternatives available, while minimizing the cost of the change, responsiveness to wage changes would be increased, thereby making supply more elastic. For example, if the wages of licensed practical nurses increased, nurses' aides would be more likely to seek L.P.N. training if the process involved was supplementary to their previous training rather than beginning student training. Alternatively, if the wages of licensed practical nurses were to decrease, a greater number might seek training as registered nurses if the process involved only one additional year instead of three or four years. Not only does the additional training period mean a greater cost in time and money, it also increases uncertainty as to the market situation upon completion of the program.

Increasing the productivity of health manpower means receiving more output from a given input. The educational system can increase productivity by offering continuing education courses, refresher courses, and by making formal education more applicable and practical to situations workers encounter after completing their education. Concentration of the determination and utilization of an optimum combination of inputs to provide a given level of health services is needed. If the productivity of health manpower can be increased, it may not be necessary or beneficial to increase their supply.

The major emphasis in health manpower education has been on increasing the supply. This means altering the supply of health manpower such that more man-hours will be offered at every given wage.

4. Distribution of Manpower - Inferences from the Hierarchies

The rural health problem is a distribution problem. Increasing the supply of health manpower will not alleviate the rural health problem unless a portion of the increased supply locates in rural areas. Graduates locate where there are jobs. Therefore, establishment of an education program in a community does not insure an increased supply of manpower for that particular community.

Institutions in the region were asked for information regarding placement of graduates. Some institutions did not have records of where their graduates had located. In Appendix F there is a summary of the positive responses. Some estimates were derived from the respondents' general knowledge, whereas, others were based on time series data varying in length from one to ten years. Due to the inconsistencies and noncomparability of the data, statistical tests could not be calculated. Therefore, the data are merely presented with the sources.

If the distribution of health manpower prior to inception of a program is not known, then determination of the distributional impact of the program is difficult. In order to identify impact, more than one point in time must be observed. If time series data are not available, then indirect means must be used to infer impact from the existing situation. One way this can be done is to compare the existing situation in communities having a program with communities having no program.

The most common comparison for determining impact is to contrast the manpower population ratio of a program community with the manpower population ratio of a non-program community. Aside from the fact that a higher health manpower population ratio does not necessarily mean a better level of health care, there are other problems in using such ratios. One objection is that such a methodology is too simple and is neglectful of important variables such as migration, attrition, population changes, and the sizes of the market areas.

Manpower population ratios were computed for each community in the study region. The ratios for communities having a particular program were compared with those for communities not having the program. The expectation was that $\left(\frac{HM_{ij}}{Pop_i} > \frac{HM_{\bar{i}j}}{Pop_{\bar{i}}}\right)$ (where HM_{ij} is the number of health manpower of type j in community i, and Pop_i is the population of community i) if E_{ij}, program of type j exists in community i, but does not exist in $\bar{i}$. Computations for the study region did not reveal such a pattern. There is an inherent bias toward a higher ratio in a community having a particular program if the program instructors are classified as the same type of manpower used in computing the ratio. As an example, cities having a school of pharmacy will tend to have a higher pharmacist to population ratio, not necessarily because graduates remain there, but because a portion of the resident pharmacists are teachers.

Comparative Methods

Several other comparative methods have been devised to evaluate the impact of education on manpower distribution. A few of these methods are presented below:

1. Let HM_{ij} be the number of health manpower of type j in community i, and let Pop_i be the population of community i. A comparison can be made between the percentage of the region's manpower and the percentage of the region's population, community i has by $\left(\frac{Pop_i}{\sum_i Pop_i} - \sum_i \frac{HM_{ij}}{HM_{ij}}\right)$. The expectation is that the more negative the number, the greater the probability that community i has an education program of type j. If the results of this method are taken to be an indication of impact, then it is possible to identify the location of some types of programs by the differential distribution of manpower. However, a definite pattern does not exist and the location of most programs can not be identified by this means.
2. Using the same notation as above, $\left(\frac{HM_{ij}}{C_i}\right)$ was computed but revealed little. A problem exists in that communities with small HM_{ij} and low C_i, result in figures similar to cities with high C_i and high HM_{ij}. When comparing two communities i and $\bar{i}$, it is only when $\left(\frac{HM_{ij} - HM_{\bar{i}j}}{HM_i}\right) > \left(\frac{C_i - C_{\bar{i}}}{C_i}\right)$ that $\left(\frac{HM_{ij}}{C_i} > \frac{HM_{\bar{i}j}}{C_{\bar{i}}}\right)$ The expectation is that if graduates remain in the city where educated, the number of manpower per unit of economic activity

would be greater in program communities than in non-program communities. No such pattern was revealed.

3. A ratio has been computed that compares the percentage of the region's manpower of type j in community i with C_i, the community's level of economic activity; that is, $\left(\frac{\frac{HM_{ij}}{\sum_i HM_{ij}}}{C_i}\right)$. No pattern to the values is discernible, and it is not possible to isolate communities having programs by observing the ratio magnitude.

By using the previously discussed methods, it was not feasible to predict with any degree of accuracy the location of health education programs. One problem was that there were few observations within each program type. Also, a time lag existed between the origin of a program and its impact on the supply of health manpower in a community. Therefore, the different dates of origin and length of programs must be incorporated into the analysis.

Due to the problems discussed above and the lack of a complete set of data, inferences can only be made regarding the impact of manpower education on the distribution of manpower. From Appendix F it can be seen that there is a tendency for a larger percentage of graduates to locate in cities with higher economic indices. Consider the positive responses from schools of licensed practical nursing. The lower the health index is for a community having such a program, the lower is the percentage of graduates remaining in the community. For a comparison within one institution, consider the school for registered nurses in Laramie, Wyoming. A larger percentage of the graduates goes to Casper and Cheyenne (both have higher indices) than remains in Laramie. Although there are data problems, the implication is that graduates distribute themselves according to employment opportunities. The indices of economic and health activity indicate the relative employment opportunities of communities.

When trying to identify the impact of a particular event or action, isolation from other things occurring simultaneously is not possible. Therefore, when a non-random relationship is identified, the cause is sometimes wrongly attributed to the action under observation. This happens when a relationship is observed between place of education and place of residency. Studies indicate that there is a positive relation between the two; that is, there is a higher probability of locating in community i if education occurred there.

Since most health education programs exist in the more urbanized communities, there is an inherent bias toward overstating the effect of education on location. Much of the impact attributed to place of education should be attributed to the desirable socio-economic conditions existing in cities having health education programs. Although graduates tend to locate where educated, one is not a function of the other. Both may be functions of another variable not included in the analysis. In the case of place of education and location after graduation, the other variable is the level of economic and health activity. For example, medical schools are located in metropolitan areas. Studies have shown that a large percentage of physicians remains where educated. However, the conclusion is not that a physician locates in that area because he or she obtained their education there, but because of favorable employment opportunities.

In a rural setting, the act of locating a health education program in that area does not assure a positive impact on manpower distribution. There must be desirable socio-economic conditions and employment opportunities in a community to induce the health manpower educated there to become residents. An example from this study region is the dietician program at the University of Wyoming in Laramie. Opportunities are limited for dieticians in Wyoming because most hospitals in Wyoming do not hire them on a regular basis. There are four positions in Casper, three in Cheyenne (two full-time and one part-time) and one in Laramie. Without completion of the internship, a dietician cannot practice. However, the only internship program in the region is in Salt Lake City. Consequently, less than 8% of the graduates from the program remain in Wyoming.

Four types of programs were investigated in detail: dental hygienist, physical therapist, licensed practical nurse, and registered nurse. A hierarchy was computed for each of the four types of manpower (see Appendix G). A proportionality index based on the number of the particular manpower was computed for each community. Let HM_{ij} be the number of health manpower of type j who are located in community i. The proportionality index for community i with respect to occupation j would then be $\left(\frac{HM_{ij}}{\sum_{i} HM_{ij}}\right)$.

Observations can be made regarding the structure of the health delivery system in communities by comparing indices for facilities and professional personnel with the indices for various allied health manpower. A comparison can be drawn between the health system hierarchy and the hierarchy for each occupation. Another comparison can be made among the hierarchies established for each health occupation. The conclusion is that for some communities, there is not only a change in the value of their proportionality index, but there is group change as well.

To obtain a better perspective of the relationship between the registered nurse and licensed practical nurse hierarchies, a ratio $\left(\frac{\text{LPN}}{\text{RN}}\right)$ has been computed for each community. Appendix H is the ordering of the ratios according to the magnitude of the economic index for the first six groups of the economic system hierarchy. The ratio varies over the region and there is not a definite pattern. Though the hypothesis has not been tested, the variation in the ratio indicates there is substitution between the two occupations.

To facilitate comparison of the existing health manpower distribution with the location of education, in Appendix G a separate map is provided for each occupation. Communities having the respective health education programs are circled.

The service area of each health manpower education program can be analyzed in the following ways. First, the market area from which students are drawn could be identified. Second, the area serviced with respect to supplying trained manpower could be determined.

The first approach concerns the demand for education, whereas, the second refers to the distribution of the supply of manpower. Data on the original residency of students in training are not available. However, the largest percentage of the enrollment is in-state students. In Wyoming, there is usually only one program of a particular type, therefore, communities within the state do not compete for students demanding a particular type of training. The single program services the entire state.

By viewing the hierarchical map for a specific type of manpower, it should be possible to get an idea of the area served by a program with respect to supplying trained manpower. When there is one statewide program of a particular type located in a community lower in the manpower hierarchy than other cities in the state, then the program services the higher ranking cities. When the program is located in a higher-order city, it must service the lower communities. This has been confirmed by the responses from the institutions, and by the fact that a large percentage of graduates, sometimes over 90%, remains in the state where educated. Within the state, graduate placement seems to be positively related to the level of economic and health activity.

Normally, the expectation is that placement is inversely related to distance. Such is not the case in Wyoming. The reason is that cities having programs are surrounded by very small communities which do not offer employment opportunities. This can be seen in the maps for the different types of manpower in Appendix G. Cities high in the regional hierarchies, Denver and Salt Lake City, retain most of the graduates from programs located in those cities. It is difficult to identify the portion of graduate placement due to the level of economic activity and the portion due to the distance variable.

C. CRITERIA FOR ESTABLISHING HEALTH MANPOWER EDUCATION PROGRAMS

There appears to be a divergence between the locational patterns of the educational and economic systems. In order to explain the difference, the criteria for establishing and locating health manpower education programs must be identified. If the criteria for location in the educational system are not the same as those for location decisions in the economic system, it should be expected that the two location patterns would be different.

A survey was not conducted to determine the criteria existing in the region for the establishment and location of health manpower education programs. However, in discussions with persons in the health and education industries, several subjective criteria were mentioned repeatedly. A list of these criteria is provided below, followed by an evaluation of each.

The decisions to initiate and locate education programs are not independent events. Usually a group of citizens or an institution decides to initiate a program to be located in their community. The program must be justified. Once approval is granted through the proper political channels, the location is thus determined. In deciding upon the location first, alternatives are not considered.

The criteria are: (1) existence of need for the type of health manpower to be educated; (2) availability of educational and clinical facilities; (3) qualified instructors and personnel: (4) community support: and (5) availability of funds.

D. EVALUATION OF CRITERIA

1. Existence of Need

There is no fixed method by which to determine need. Rather, methods range from the comparison of differentials in manpower population ratios to the frequency of requests from the industry for particular types of manpower. In some cases, agencies determine need by using Department of Labor statistics and Employment Security Commission statistics.

A shortage is often quoted as justification for increasing education programs. Shortage in an economic sense means the existence of excess demand at a given price; that is, at a given price, fewer man-hours are offered for sale than are demanded. Since the market adjustment process is dynamic and occurs over time, shortages materialize as a result of a market working toward equilibrium. The shortage persists if the price (wage) is held below the equilibrium price (wage) by some outside force (Arrow, 1959). This seems true of allied health manpower. If employers (physicians and hospitals) prefer to maintain low wages, a bias may exist toward initiating additional health manpower education programs. If the market is allowed to operate for allied health manpower, wages could increase and alleviate the shortage.

For example, if it is beneficial for physicians and hospitals to pay a low wage for nurses, then there may be a bias toward increasing the supply of nurses. However, there is a high percentage of inactive nurses. Therefore, instead of increasing the supply, it may be a better policy to allow wages to increase, thereby attracting some inactive nurses back into the labor market.

When the term shortage is used in the health and education industries, it is not shortage in the economic sense. Instead, the term represents the difference between supply and a subjective estimate of the quantity needed to meet some level of health care without considering price. By basing decisions on need rather than on demand, a negative price could result.

Health manpower population ratios are sometimes used to determine need. This procedure can be deceiving, and decisions based thereon can result in distortions in the market. When using manpower population ratios, the differential sizes of market areas are not taken into account. Population figures represent the number of people living in a community, not the number of people served by a community. The number of health manpower reflects the quantity of health service demanded by the market area, not just the community demand. The idea of market areas is derived from the assumption that cities serve more than their immediate population. Consider Scottsbluff, Nebraska, and Laramie, Wyoming. From the health hierarchy, their indices are .31606 and .17472, respectively. The implication is that Scottsbluff serves a larger area than does Laramie. The populations of Scottsbluff and Laramie are 14,507 and 24,700, respectively. This implies that even though Scottsbluff is a smaller community than Laramie, it has a higher manpower population ratio than does Laramie, not because it has a better health delivery system, but rather because it serves a larger market.

Table VII-3 includes comparisons between cities of approximately the same size but of different levels of economic activity, and between cities of different size but like indices. Physician-population ratios are included in the table. A comparison is made between cities with the same ratio but different levels of economic activity. Appendix I presents the physician-population ratio for communities in the first six groups of the economic hierarchy. The cities are ordered according to the magnitude of their economic index. From Table VII-3 and Appendix I, it appears that when $[Pop_i = Pop_{\bar{i}}]$, but $[C_i > C_{\bar{i}}]$, the ratio $\left(\frac{HM_{ij}}{Pop_i} > \frac{HM_{\bar{i}j}}{Pop_{\bar{i}}}\right)$. If such a relationship does exist, the idea that a relatively higher manpower population ratio means a better level of health care could be discredited. The higher ratio may instead reflect the fact that the market area for the high ratio community is larger and, therefore, services a greater number of consumers

TABLE VII-3

ILLUSTRATIONS OF POPULATION VARIATION WITH RESPECT TO VARIATION IN THE LEVEL OF ECONOMIC ACTIVITY

Community	Population	Level of Economic Activity[a]	Phys/pop.
A. Communities of Similar Size, and Differing Levels of Economic Activity			
Brush, CO	3,377	.2472	.8884
Buffalo, WY	3,394	.1637	1.1785
Newcastle, WY	3,432	.1772	.8741
Preston, ID	3,310	.2380	.9063
B. Communities of Different Size, and Similar Levels of Economic Activity			
Laramie, WY	24,700	0.6293	.9717
Sterling, CO	10,636	0.6044	1.7864
Sidney, NB	6,403	0.3930	1.0932
Rock Springs, WY	12,100	0.3913	.6612
Rawlins, WY	7,855	0.3226	1.7823
Vernal, UT	3,908	0.3152	1.2794
Craig, CO	4,205	.3496	.2378
Alliance, NB	6,862	.3329	1.4573
Idaho Falls, ID	35,776	1.4780	1.7051
Rapid City, SD	43,836	1.4302	1.5512
C. Communities of Different Size, and Differing Levels of Economic Activity, but Similar Physician, Population Ratios			
Greeley, CO	40,129	1.3121	2.1929
Gordan, NB	2,106	.1613	2.3742
Scottsbluff, NB	14,507	.9172	1.7922
Rushville, NB	1,137	.1231	1.7590

[a] The level of economic activity is described in Chapter III under the heading, "centrality index", and is based on 74 economic variables.

than its immediate population. Further information may be gained by testing the hypothesis that $\left(\frac{HM_{ij}}{Pop_i} = f(C_i)\right)$ by regression techniques. For some types of occupations more of the variation might be explained by including some variable for distance, possibly either $(D_{i\bar{i}})$ or $(D^2_{i\bar{i}})$, where $D_{i\bar{i}}$ is the distance from $\bar{i}$ to i. The equation would then become $\left(\frac{HM_{ij}}{Pop_i} = f(C_i, D_{i\bar{i}})\right)$. Since there is a vast amount of computation involved in computing the distance from i to every $\bar{i}$, a better approach is to use only the distance to the closest cities of a specified higher group, depending upon the type of manpower being analyzed.

By using the concept of hierarchical demand structures, health education programs could be established on the basis of demand for health manpower rather than need. The health hierarchy is developed from a stock representation of a flow of demand for health services over a period of time. Therefore, it is an indication of demand, not an indication of a subjective phenomenon such as need. By using need as a criterion for location, the results will be non-optimal locations of health manpower education programs.

2. Availability of Facilities

The decision to initiate and locate a program on the basis of existing facilities limits the consideration of alternative sites. An inherent bias is created against rural communities having no facilities. The justification for locating programs in communities with existing facilities is the cost savings. An agglomeration of health education programs in larger communities results with little impact on the rural health delivery system. The agglomeration is continually supplemented as programs are located individually at different points in time. Once a complex begins to develop, individual programs tend to be located there. If decision makers, instead of locating health education programs individually, would take a more comprehensive view and locate health and education complexes in rural communities, then these communities would have something upon which to build.

3. Qualified Personnel

One of the major constraints in health education is the recruitment of qualified personnel. In order to be approved, most programs must employ instructors meeting certain qualifications. It is difficult for smaller institutions to offer a competitive wage to attract such personnel. The other difficulty is the attraction of highly trained people to rural areas without a health complex and desirable socio-economic conditions.

4. Community Support

The overshadowing factor in determining location of health education is community support. In fact, the community residents often propose the program. When this happens, decision makers do not consider optimal location by evaluating alternatives. Rather, they approve or disapprove the particular community as a location site. Larger communities tend to have better-organized interest groups which provide a base for community support and activity. Rural communities often lack such a base.

5. Availability of Funds

Often, the education program established depends on the availability of funds to begin and to sustain the program. "Seed" money is often provided by agencies other than the state. Funds to sustain the program are often dependent on enrollment, therefore making it essential to locate such that there will be a sufficient demand or enrollment. The types of health manpower education programs needed in a region are not always the ones receiving the most funds. Decision-makers may re-order priorities to take into account differential funding.

An attempt was made to ascertain an optimal size for various allied health programs. Consultations with people inside the study region and with certain individuals outside the study region, who were thought to have access to such information, yielded only "rules of thumb." In many cases, such rules were minimal or threshold levels which were required to begin a program. It was not possible to determine how the rules were derived. The "rules of thumb" regarding the size in terms of student enrollment in existing programs were subjective. The impact of variations from the guidelines could not be states. There was no optimal size or range utilizing objective criteria. The procedure followed was to start small and then, depending upon success, to expand to a point where it was no longer deemed desirable to expand further. Data from the BHME publications were used to compile Table VII-4. Figures are for the United States and show enrollment for selected programs. Enrollment figures for programs in the region can be found in Appendix E.

E. CONCLUSION

Given the nature of the data on health manpower education programs, it was not possible to test the hypothesis that the health manpower education system is functionally dependent on either the health-care delivery system or the economic system. First, information is required on place of residence

TABLE VII-4

FULLTIME ENROLLMENT RANGE FOR SELECTED ALLIED HEALTH PROGRAMS IN JUNIOR COLLEGES FOR THE UNITED STATES

Number of Students	Dental Asst	Dental Hyg	Dental Lab techni	Enviro Sci techni	Medical Lab techni	LPN	RN	Surgical Techni	Radio Techni
1- 4	1	0	1	1	9	0	1	2	1
5- 9	4	1	0	4	10	2	2	6	5
10- 19	21	4	5	2	27	40	7	15	30
20- 29	39	8	2	4	21	65	17	12	16
30- 39	14	14	5	3	8	42	13	2	11
40- 49	13	11	4	0	3	39	35	0	13
50-100	24	20	4	2	13	63	139	1	16
over 100	4	4	1	0	6	22	121	1	3

___ represents the mode

Source: Allied Health Programs in Junior Colleges/1970.

for students enrolling in programs. For some programs such as medical education, students may be willing to migrate a great distance. For other programs, students may not travel more than five or ten miles. In the absence of such information, it would be difficult to estimate the optimal location of any health manpower education program.

Secondly, information on the optimal size range of each health manpower education program is needed. What is the minimum feasible size for some program? And at what point does increased program size lead to increasing costs such that it would be cheaper to initiate a new program elsewhere? (That is, at what point do diseconomies of scale indicate a necessity of starting new programs rather than increasing present ones?)

With some definitive answers to the above points, it becomes feasible to consider optimal location. In the absence of this information, speculation is the only tool available to determine optimal location. The recommendation is that research efforts be directed to find solutions to the above problems.

CHAPTER VIII

POLICY IMPLICATIONS OF THIS RESEARCH

The conclusions of this study of the economic system, the health-care delivery system, and the health manpower education system may potentially alter present research approaches to health manpower education and present health manpower education policy. In this chapter, possible implications for both research and policy are offered.

A. HEALTH-CARE IN SOME COMMUNITY

To conduct consumer surveys to determine the range of economic and health-care activities used by residents in a community is feasible. However, a reasonable expectation is that a survey of the range of the activities offered in the community would yield similar information. Therefore, if all residents purchase refrigerators and dental services, the inference is that (a) if refrigerators and dental services are available in some community then some people may buy in the community, and some may buy elsewhere; and (b) if neither refrigerators nor dental services are available in the community, then the residents must buy elsewhere. Conducting a survey of consumer purchase patterns for refrigerators and dental services produces more information; however, the added information may not compensate for the extra cost.

The determination that (a) communities can be ordered, and (b) activities (both economic and health-care) can be ordered in a system consistent with central place theory has been established. Inter-group marginal activities for a rural, low population density region have been identified.

The empirical results have indicated that the presence of some activity within the community is not totally related to the demand for that activity within the community--that communities can support a greater range and magnitude of activities when the notion of population is broadened to include the hinterland population as well as the indigenous community population. The concept of a Standard Metropolitan Statistical Area incorporates a similar notion by inferring that the population of some city exceeds the physical boundaries of that city and includes the peripheral population in the suburbs. In this study, the inference is that residents outside the corporate limits of some community may be as much an integral part of the community as those within the community even though the rural residents are not part of any incorporated place, per se. Identification of the exact size of the population that might be added to the indigenous population of the community is not feasible. However, a reasonable expectation is that if the indigenous populations of Communities A and B are, respectively, 4,000 and 10,000; and if the level of economic activity and the level of health-care activity are the same for both of these communities; then the total population served by these communities must be approximately the same.

Furthermore, if some order of physician services is available in a community, then the demand for that service is high enough (from both residents and non-residents) to warrant the provision of that order of physician services. Therefore, the presence or absence of some economic or health activity in a community provides indirect evidence about demand: if demand is high enough, the activity is present. Thus, the presence or absence of activities is a surrogate for household surveys of demand whether the survey is for the economic system or for the health-care delivery system.

For the smallest communities, where there are no hospital and no physician, health care might be viewed in the context of need rather than in the context of demand. To determine health-care needs in the smallest communities, formal surveys of consumers appear to be necessary.[17] Since no survey work was conducted in this study, no information is available in quantifiable form. Nevertheless, the research effort did involve the assistance of many different individuals in the seven states. These individuals represent, in varying ways, resource persons providing qualitative information about the rural health-care system. A few comments are relevant in the context of these qualitative data.

Smaller communities have various kinds of health manpower assisting in the treatment of illnesses and injuries. Some communities have chiropractors and some veterinarians. Others may have an R.N. or L.P.N. living in the community. These kinds of manpower are utilized by rural residents to provide a variety of diagnostic treatment for illnesses and injuries. These qualitative data suggest that a referral system operates from small communities to larger communities via this informal health-care delivery system.

Further, rural residents in the study region frequently utilize self-diagnosis as a method for meeting health-care needs. A variety of techniques are at their disposal. For example, unused portions of prescription medicines can be acquired from urban residents and used in the case of illness. There is reason to believe that physicians co-operate in the informal and self-diagnostic health-care system by prescribing medicines for rural residents for their medicine cabinets in the event that the medicines may be needed. Further, some physicians may engage in an informal co-operative arrangement with allied health manpower, thus making available a limited range of prescription medicines for the use of allied health individuals in their rural communities.

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[17] The delineations of both the economic and health-care delivery systems were based on demand and not on need. No attempt was made to determine the level of services needed by rural residents. The nature of such estimates is subjective and no attempt was made to incorporate this approach to health manpower and health facilities.

Research into the specific nature of the health-care delivery system should have potential value for planning. If, for example, allied health manpower and self-diagnosis are widely used in small communities, then non-physician manpower may be widely acceptable there. Research of this nature requires a survey to determine where rural residents enter the health-care system for diagnosis and treatment, since secondary data do not permit a definitive method for identifying the methods of diagnosis and treatment in rural areas.

B. DYNAMIC MODELS OR STATIC MODELS

The empirical models of the economic and health-care delivery systems in this report were derived from cross-sectional data. Thus, these models are static in nature. To have made the models dynamic across time periods, it would have been necessary to develop time-series data. This was not done.

In a more narrow sense, these models do have dynamic implications. For example, if rural development should occur, then at least one community will grow in size as a result of the development. If that community acquires higher-order economic activities, higher-order health facilities, and higher-order health manpower, then movement might occur between groups in the hierarchical system. The total number and types of activities will change for the region, thus changing the relative influence of each community in the region. To simply compare the change in one community with the rest of the system without re-submitting the whole region to the hierarchical methodology would not be consistent.

If, however, it is known that economic development will occur in some rural area, and if information is available on the size of the development, then inferences can be made about the configuration of the economic and health-care systems that will evolve. Such inferences about the future configuration of communities following development would have good potential for both health and health manpower planners. On the basis of the estimates of the future health-care delivery system, inferences could be made concerning the hospital facilities required, and the quantity and kinds of health manpower needed for employment in the community. Further, planners should be able to estimate changes in the health manpower education system required to alter the supply of health manpower for the given rural development. In this sense, the empirical models provide information about inter-group movement and have some dynamic implications for health and health manpower planning.

C. TRANSFERABILITY TO OTHER REGIONS

The economic and health-care delivery system models developed in this report were based on data collected in a region of mountains, high plains, and low population density. Are these models transferable to other regions with different characteristics--non-mountainous or high population density regions?

A definitive answer to this question is difficult. Nevertheless, there are several important considerations in answering it. First, the consumption pattern of the residents of the intermountain region is expected to parallel the consumption patterns of residents in other parts of the United States due to the influence of the communications system and the advertising system. The stimuli for consumption spending in the urban Northeast are similar to those in the rural intermountain region. Thus, the number and range of businesses in the economic system required to support some population size (both indigenous and hinterlands) are similar for a low density area and a high density area. More specifically, if Community A in southern Montana has some given range of businesses and serves a total population of X; then some Community B in New York, serving a population of size X, would have almost the same number and range of businesses.

Second, the question might be posed: "Given the low population density of the intermountain region, will the larger distances between communities in the intermountain region restrict the transferability of these results?" The answer to this question is subjective and must be so qualified. Nevertheless, if a household is located 50 miles from the nearest community in the intermountain region as compared to a household located 10 miles away in some other region, each householder travels a minimum distance of 50 and 10 miles respectively to the nearest trade center. If members of these two households require highly specialized medical services, and the householder in the study region would travel 400 miles and the one in the high density population region would travel 20 miles: then the travel distance becomes relative. It seems untenable to maintain, for example, that if residents of urban regions refuse to travel more than 25 miles for some services (assuming the service is available within a 25-mile radius), then a rural resident in a low population density region is unwilling to travel more than 25 miles for the same service. The minimum distance travelled for any commodity would then be determined by the nearest location where that commodity is available. Thus, although the distance scale may be different in urban regions than in rural regions, the empirical models developed in this study are transferable from the low population density, intermountain region to high population density, urban areas of the United States.

The authors would expect the results to be transferable to other rural areas. Certainly, the eastern part of the study region (eastern Colorado, western Nebraska, and western South Dakota) is similar to many rural parts of the United States (many small rural communities that are spaced at regular intervals). Since these rural areas fit the general pattern observed in the more mountainous areas, it would seem reasonable to expect that the results of this study region would be transferable to the rural areas.

Two conclusions have been reached: (a) the methodology is transferable to other regions, and (b) the information learned about inter-group marginal economic activities and inter-group marginal health-care activities is transferable to other non-rural areas of the United States. Since the second conclusion requires empirical demonstration for support, there remains the possibility that it could be refuted empirically. Therefore, it is proposed that a similar study be conducted in an urban region of the United States for the purpose of identifying inter-group marginal economic and health activities, and for the purpose of further testing the hypothesis that the economic system can be used as a surrogate for the health-care delivery system. Further evidence confirming the interrelationship of these systems would justify the development of operational models using economic data as a tool for both health planning and health manpower planning.

Some efforts were made in this study to develop an operational method for utilizing the economic system as a surrogate for the health-care delivery system. The results were encouraging but time and manpower did not allow an adequate investigation; hence, the preliminary results were too tentative to merit inclusion in this report.

D. HEALTH PLANNING AND THE ECONOMIC SYSTEM

Changes in economic activity result from exogenous changes in the system of production, distribution, and consumption. If exogenous changes can be identified in the system of production, distribution, and consumption; then, inferences can be made in the economic system and the health-care delivery system. For example, if a mine, factory, or similar facility is planned for a rural area, and an estimate can be made of the potential employment impact in the community; then, inferences can be made about the change in the order and magnitude of the economic system and the health system and to estimate the configuration of the new health-care delivery system by applying the IMEA and IMHA analyses. Thus, health planners can utilize the information on exogenous change in a regional economic system to estimate the change in the health system.

Planners may have to consider alterations in the existing programs of health manpower education if an increase in the number and order of health manpower in the community is needed. Further, health planners would be able to estimate the configuration of health facilities required in the community and to propose methods of developing the health facilities and health manpower in advance of the change.

If it appears necessary to increase the range and magnitude of present health manpower education programs, then the economic system, as defined by Figure IV-3, is useful for identifying some alternatives. The evidence reported in Chapter VII indicates that graduates of health manpower education programs locate in the state in which they have received their education. To attract needed manpower, a state experiencing or expecting changes in production, distribution, and consumption might initiate changes in its educational programs.

For example, in the economic system discussed in this study, it is likely that most programs would be located in communities in Group 5 or higher. A prediction has been made that northeastern Wyoming and southeastern Montana are likely to undergo substantial coal development in the next decade to meet demands for increased energy. Estimation of the actual development that will take place is difficult. If ten 10,000 megawatt coal generating power plants were constructed employing about 12,000 workers in the coal mines and steam generating plants; and if the total population impact in that area was seven residents for every new job; then the total population impact would be in the 80,000 to 85,000 range (Wold, 1972). By using the information on the economic system, inferences could be made about the economic system and the health-care delivery system. Estimates of the potential impact would be superior to the present methods which have resulted in hospitals being constructed and health manpower programs being started only when crises occur.

Further, if the emphasis for the development of new or larger health manpower education programs could be influenced by federal decision-makers, then interstate program choices might be more efficient. For example, to serve the health-care needs of the assumed population increase for northeast Wyoming, development of new or larger health manpower education programs in communities such as Rapid City, South Dakota (economic Group 4); Billings, Montana (Group 3); Casper, Wyoming (Group 4); or Sheridan, Wyoming (Group 5) could be appropriate. That is, the number of alternatives can be increased and greater attention devoted to efficiency in this way, rather than if decisions to develop health manpower education programs are narrowly restricted to intrastate considerations only.

The analysis is not rigorous. It is highly conjectural. Nevertheless, the potential for using the economic system as a method for improving the quality of health planning, health manpower planning, and health manpower program and facility planning is suggested. Strong indications are that further research into the operational interrelationships of the economic and health-care systems could prove to be of significant value to planners.

E. DATA NEEDS

Numerous references have been made herein to the difficulties encountered in finding the appropriate data. Given this problem, it would seem necessary to identify the essential data needed to permit the update (possibly every 10 years) of the economic system and health-care delivery system for the intermountain region.

1. The Economic System

The essential information would include data on the number of businesses and dollar value of retail sales volume by four-digit SIC codes. Since this would pose nondisclosure problems in small communities, it is probable that similar work would be restricted to "number of establishments." In this respect, it would be much easier to conduct the study if the several censuses of retail trade, wholesale trade, and selected services would include information on all communities. If rural areas continue to experience a shortage or absence of health services, data on these communities should be made available, permitting a more analytical and meaningful analysis of the specific health needs of these areas.

2. The Health-Care Delivery System

The essential data needs for identifying the health-care delivery system could be met with the compilation of more detailed data available from health occupation licensing forms. More extensive data on hospitals, including types of hospital employees, costs, and patient characteristics, are needed. Also, survey information would be beneficial on the travel patterns of consumers utilizing the health-care delivery system.

3. The Health Manpower Education System

Two data requirements for identifying the health manpower education system are the place of residence of students prior to enrollment and residence and employment status of graduates. Additional information would be useful regarding the optimal program size and the cost structure of various sizes and types of programs.

4. The Use of Consumer Travel Pattern Data

To test the hypothesis that consumers follow similar travel patterns to purchase health and non-health services would require a detailed investigation of the trips taken by consumers. A Wyoming transportation study was being conducted at the same time as this study. Unfortunately, the transportation study did not meet the needs of this analysis since the former sought information on transportation patterns within Wyoming and excluded information on origins and destinations outside Wyoming. Nevertheless, these kinds of data would seem important and useful for delineating the service areas for both the health system and the economic system.

F. CONCLUSION

Although this study did not involve the estimation of health needs and the use of time-series data, the empirical results indicated (a) that the methodology provided meaningful models of the economic and health systems in the intermountain region, and (b) that the economic system data are easier to obtain than the health-care system data; and given the close relationship of the two systems, the economic system has the potential of being a surrogate for the health-care delivery system.

In view of the limited nature of this study, a low population density region, it may be advisable to apply the methodology in a more densely populated region. Offered in this chapter are some approaches to the problems of cross-sectional data and transferability that may make further research effort less important and unnecessary.

A well-organized and informal health-care delivery system (not physician and hospital oriented) may exist in many small and rural places in the intermountain region. If such is the case, then rural and small community residents (1,000 persons and below) may be more receptive to primary health care by allied health manpower.

CHAPTER IX

SUMMARY AND CONCLUSIONS

The results of this study confirm the thesis that the theory of hierarchical demand structures can be an efficient and effective basis for health planning. This conclusion must, however, be tempered with the observation that specific planning techniques derived from the methodology employed in this study must await further empirical work. The conclusions of the study can be summarized by discussing the hypotheses listed in Chapter I.

A. HYPOTHESIS ONE

There are statistically significant similarities between the hierarchical structures of the economic and health-care delivery systems.

To test this hypothesis a methodology was developed which was comprised of a centrality index as the measure of the economic importance of a central place, and of a heuristic programming algorithm which served the purpose of efficiently forming hierarchical groups of central places based upon their centrality index scores. The methodology was applied to 538 central places in a region centering upon the state of Wyoming. Two hierarchies were formed--one based on economic characteristics in each of the places and the other based on health delivery characteristics.

Statistical tests comparing the two hierarchies were performed by contrasting the rankings of central places in the health and economic hierarchies. Spearman's rank correlation coefficient and Kendall's rank correlation coefficient indicated highly significant similarities between the two rankings. Parametric tests were also performed by assuming that the health index values for communities were a function of the economic index values. A regression equation was estimated and the parametric values were shown to be highly significant.

It was suggested, however, that the statistical tests may have masked some important additional comparisons between the economic and health systems. The observation was made that the health-care delivery system seems to be less developed than the economic system. There were fewer communities in the top five hierarchical groups of the health system as compared to the economic system. This meant that there was a tendency for communities to fall into a lower health group than economic group.

Extensions of this study are suggested by the results of the comparisons between the economic and health systems:

1. A second application of the methodology to health and economic data from some time period of five to ten years previous to, or after this study would aid in determining whether the relationship between the economic and health service systems remains static or changes over time. It might be hypothesized that development of the health system lags behind the development of the economic system. A second study could test this hypothesis.
2. Application of the methodology to an urban study region would allow comparisons between the development of the urban health and economic systems and the rural health and economic systems.

B. HYPOTHESIS TWO

Hierarchical service areas are preferable to political units (e.g., counties and other popular area designations) as units for health planning.

A review of the methodologies employed in the formation of Rand McNally Trade Areas, Bureau of Economic Analysis Economic Areas, and Functional Economic Areas was included in this study as well as a summary of other methods which have appeared in the literature. The general criticisms of these methodologies were that the hierarchical notion has often been omitted from the methods employed, that inappropriate data were employed to reflect rural economic activity, and that political boundaries were often assumed to equal economic boundaries with no justifying arguments presented.

There are two particular advantages to the methodology of formulating services areas used in this study. First, it is appropriate for rural regions because it takes into account quite small communities (less than 4,000 population in this study). Second, since the hierarchical concept is incorporated, it is possible to use service areas in the planning of a wide range of health activities--from the very basic services requiring small service areas, to the sophisticated facilities and manpower serving very large areas.

C. HYPOTHESIS THREE

It is possible to make inferences about health services which a community and its market area population can support by noting the number and types of business establishments located in the area.

This task was not fully accomplished but procedures which might be followed in making these inferences were suggested. Characteristics of communities in each group were described for the economic and health service hierarchies. Propositions from central place theory were derived and applied to the hierarchies to define intergroup marginal economic activities (IMEA's) and intergroup marginal health activities (IMHA's). These propositions were then used to derive specific empirical rules which were operational in determining IMEA's and IMHA's for the study region. However, since no attempt was made to relate the IMEA's and IMHA's, the study has not indicated specifically how knowledge about health services can be gained by counting business establishments. An extension of the study would undertake this task.

A final comment concerning hypothesis three is appropriate. While specific rules of thumb were not provided for equating economic activities and health activities, there were broad planning implications arising from the two hierarchies. If changes in the economic hierarchy could be anticipated or forecasted by planners, then knowledge of the previous health system would give indications of what health activities could be supported by specific communities after the economic change occurred.

D. HYPOTHESIS FOUR

The hierarchical nature of the economic system can serve as an efficient base for locating health manpower education programs.

The main conclusion drawn from the study with respect to this hypothesis was that neither the economic system nor the health-care delivery system can be used as a surrogate for optimally locating health manpower education programs. Data problems were the major constraint in evaluating the education system. In many cases, data were non-existent. The reliability of the available data was questionable and was often only a subjective estimate.

Neither was it possible to make inferences concerning the influence of educational programs on the location of health manpower; the main reason being that information on the place of residence for students enrolling in programs and their dispersion upon graduation was not available. It was suggested that socio-economic variables and urbanization may play key roles in determining health manpower location.

Finally, this study has suggested that some of the criteria used in health facilities and manpower planning are deficient. It was pointed out that manpower-population ratios do not take into account the variations in the size of service areas for a particular type of manpower as the population density changes. It was also argued that justifying new facilities on the basis of the existence of supporting facilities biases the location decision against rural areas which generally do not have the supporting facilities.

APPENDIX "A"

LIST OF 74 ECONOMIC VARIABLES USED TO IDENTIFY THE ECONOMIC SYSTEM

This appendix is a list of the 74 economic variables used to identify the economic system. Each variable is identified by its Standard Industrial Classification (SIC) code, the name of the variable, a description of the businesses included for each variable, and the data source for the variable.

Some of the 74 variables listed in this appendix have not been assigned SIC codes by the Department of Commerce. Arbitrary 4-digit designations have been made for these variables. Those SIC code designations that were developed for this study have been identified by an asterisk (*).

Definitions and Sources of SIC Codes

SIC Code	Definition	Source
2010	Meat Packing Plants - Establishments primarily engaged in the slaughtering of cattle, hogs, sheep, lambs, calves, horses, and other animals, except small game, for canning, curing and making meat products.	D & B+
2086	Bottling Plants - Establishments primarily engaged in bottling soft drinks and carbonated waters.	Yellow Pages
2711	Newspaper Publishing - Establishments primarily engaged in publishing newspapers, or in publishing and printing newspapers.	D & B
2911	Petroleum Refining - Establishments primarily engaged in producing gasoline, kerosene, distillate fuel oils, lubricants and other products from crude petroleum and its fractionation products through straight distillation of crude oil, redistillation of unfinished petroleum derivatives, cracking or other processes.	D & B
3270	Concrete Products - Establishments primarily engaged in manufacturing and selling concrete blocks, bricks and products and ready-mixed concrete.	Yellow Pages
3993	Signs and Sign Painting - Establishments primarily engaged in manufacturing electrical, mechanical, cutout, or plate signs including neon signs.	Yellow Pages
4213	Trucking, Not Local - Companies primarily engaged in furnishing "over the road" trucking service either as common carriers or under special and individual contracts or agreements (i.e., heavy hauling, motor freight, and liquid and dry bulk trucking).	Yellow Pages
4832	Radio Broadcasting Stations - Stations primarily engaged in activities involving the dissemination by radio to the public of aural programs (consisting of voice and music and the like).	D & B
5012	Wholesale Automobile - Establishments primarily engaged in the wholesale distribution of new and used passenger automobiles, trucks, and other motor vehicles.	D & B

SIC Code	Definition	Source
5013	Wholesale Automotive Equipment - Establishments primarily engaged in the wholesale distribution of motor vehicle parts and accessories, and filling station and garage service equipment (not tires).	D & B
5014	Wholesale Tires and Tubes - Establishments primarily engaged in the wholesale distribution of rubber tires and tubes for passenger and commercial vehicles.	D & B
5022	Wholesale Drugs, Drug Proprietaries and Druggists' Sundries - Establishments primarily engaged in the wholesale distribution of drugs, drug proprietaries, druggists' sundries, and toiletries.	D & B
5041	Wholesale Groceries - Establishments primarily engaged in the wholesale distribution of a general line of groceries and related products (i.e., bakery products, canned goods, coffee, flour) or frozen foods (i.e. vegetables, juices, meats, fish, poultry, pastries and other "deep freeze" products).	D & B
5045	Wholesale Confectionery - Establishments primarily engaged in the wholesale distribution of confectionery, such as candy, chewing gum, salted or roasted nuts, popcorn, fountain fruits, and fountain syrups.	D & B
5064	Wholesale Electrical Appliances, Television and Radio Sets - Establishments primarily engaged in the wholesale distribution of radio and television sets and household electrical appliances.	D & B
5072	Wholesale Hardware - Establishments primarily engaged in the wholesale distribution of hardware, except automobile hardware.	D & B
5081	Wholesale Commercial Machines and Equipment, and Farm Machinery and Equipment - Establishments primarily engaged in selling wholesale commercial machines and equipment, such as office, store and business machines and equipment, and the distribution of agricultural machinery and equipment for use in the preparation and maintenance of the soil, the planting and harvesting of crops, and other operations and processes pertaining to work on the farm, and dairy farm machinery and equipment.	D & B
5087	Wholesale Equipment and Supplies for Service Establishments - Establishments primarily engaged in the wholesale distribution of equipment and supplies for barber shops, beauty parlors, power laundries, dry cleaning plants, upholsterers, undertakers, and related personal service establishments.	D & B

SIC Code	Definition	Source
5096	Wholesale Paper and Its Products - Establishments primarily engaged in the wholesale distribution of paper and its products, including stationery and kindred supplies.	D & B
5097	Wholesale Furniture and Home Furnishings - Establishments primarily engaged in the wholesale distribution of household and office furniture, and home furnishings.	D & B
5211	Lumber and Other Building Materials Dealers - Retail establishments primarily engaged in selling to building contractors or to the general public a general line of building materials.	Yellow Pages
5221	Plumbing and Heating Equipment Dealers - Establishments primarily engaged in the retail sale of plumbing and heating equipment, and supplies.	Yellow Pages
5231	Paint, Glass and Wallpaper Stores - Establishments primarily engaged in the retail sale of paint, glass, and wallpaper, or any combination of these lines.	Yellow Pages
5251	Hardware Stores - Establishments primarily engaged in the retail sale of basic hardware lines.	Yellow Pages
5252	Farm Equipment Dealers - Establishments primarily engaged in the retail sale of new and/or used farm machinery and equipment, and farm production supplies.	Yellow Pages
5311	General Merchandise Stores - Retail stores carrying a general line of apparel, home furnishings, dry goods, housewares, commodities--known as variety or department stores.	Yellow Pages
5341	Vending Machine Operators - Establishments primarily engaged in the retail sale of products by means of vending machines or juke boxes.	Yellow Pages
5411	Grocery Stores - Stores known as supermarkets, food stores, or grocery stores primarily engaged in the retail sale of canned foods and dry goods, fresh fruits and vegetables, and meats, fish, and poultry.	Yellow Pages
5421	Meat Stores - Establishments primarily engaged in the retail sale of fresh, frozen, or cured meats; poultry; fish; shellfish; and other sea food.	Yellow Pages
5441	Candy, Nut, and Confectionery Stores - Establishments primarily engaged in the retail sale of candy, nuts, sweetmeats, and other confections.	Yellow Pages
5451	Dairy Products Stores - Establishments primarily engaged in the retail sale of dairy products such as milk, cream, butter, cheese; and related products to over-the-counter customers or for home delivery.	Yellow Pages

SIC Code	Definition	Source
5462	Retail Bakeries - Establishments primarily engaged in the retail sale of bakery products.	Yellow Pages
5499	Health Food Stores - Establishments primarily engaged in the retail sale of health foods.	Yellow Pages
5511	Motor Vehicle Dealers (New & Used) - Establishments primarily engaged in the retail sale of new automobiles, or new and used automobiles.	Yellow Pages
5521	Motor Vehicle Dealers (Used Cars Only) - Establishments primarily engaged in the retail sale of used cars but making no sales of new automobiles.	Yellow Pages
5531	Tire Battery and Accessory Dealers - Establishments primarily engaged in the retail sale of automotive equipment such as automobile tires, batteries, and other automobile parts and accessories.	Yellow Pages
5541	Gasoline Service Stations - Gasoline service stations primarily engaged in selling gasoline and lubricating oils, and which may sell automotive merchandise or perform minor automobile repair work.	Yellow Pages
5592	Establishments primarily engaged in the retail sale of automobile passenger trailers, mobile homes, and campers (pick-up coaches).	Yellow Pages
5611	Men's and Boys' Clothing and Furnishings Stores - Establishments primarily engaged in the retail sale of men's and boys' ready-to-wear clothing and furnishings.	Yellow Pages
5621	Women's Clothing Stores - Establishments primarily engaged in the retail sale of women's ready-to-wear clothing.	Yellow Pages
5641	Children's and Infants' Wear Stores - Establishments primarily engaged in the retail sale of children's and/or infants' ready-to-wear clothing and accessories.	Yellow Pages
5651	Family Clothing and Western Wear Stores - Establishments primarily engaged in the retail sale of ready-to-wear clothing and accessories for men, women and children, without specializing in any one line, or engaged in the retail sale of western wear for the family.	Yellow Pages
5661	Shoe Stores - Establishments primarily engaged in the retail sale of any one line or a combination of the lines of men's, women's, and children's footwear.	Yellow Pages

SIC Code	Definition	Source
5712	Furniture Stores - Establishments primarily engaged in the retail sale of household furniture and home furnishings, with or without major appliances and floor coverings.	Yellow Pages
5713	Flooring, Drapery and Upholstery Stores - Establishments primarily engaged in the retail sale of floor coverings (i.e. carpets, rugs and floor tiles), draperies, curtains, and upholstery.	Yellow Pages
5722	Household Appliance Stores - Establishments primarily engaged in the retail sale of major appliances such as electric and gas refrigerators and stoves; and household appliances such as electric irons, percolators, hot plates, and vacuum cleaners. May include public utility companies which operate stores primarily engaged in the sale of appliances for household use.	Yellow Pages
5730	Music and Television Stores - Establishments primarily engaged in the retail sale of radios, television sets, record players (high fidelity and stereo), musical instruments, and phonograph records.	Yellow Pages
5812	Restaurants - Establishments primarily engaged in the retail sale of prepared food and drinks for consumption on the premises, does not include establishments primarily engaged in the retail sale of alcoholic beverages.	Yellow Pages
5912	Drug Stores and Proprietary Stores - Establishments engaged in the retail sale of prescription drugs and which may carry a number of related lines such as cosmetics, toiletries, tobacco, and novelty merchandise.	Yellow Pages
5932	Antique Stores - Establishments primarily engaged in the retail sale of antique furniture, home furnishings, and objects of art. Does not include secondhand stores.	Yellow Pages
5933	Secondhand Stores - Establishments primarily engaged in the retail sale of secondhand goods such as secondhand clothing, shoes, and furniture . Includes pawnshops. Does not include salvage and junk dealers.	Yellow Pages
5942	Book and Stationery Stores - Establishments primarily engaged in the retail sale of books and/or stationery.	Yellow Pages
5952	Sporting Goods - Establishments primarily engaged in the retail sale of sporting goods.	Yellow Pages

SIC Code	Definition	Source
5953	Bicycle Shops - Establishments primarily engaged in the retail sale of bicycles, and bicycle parts and accessories.	Yellow Pages
5962	Feed Stores and Farm and Garden Supply - Establishments primarily engaged in the retail sale of hay, grain and feed; or engaged in the retail sale of seeds, bulbs , nursery stock and other farm, lawn, and garden supplies.	Yellow Pages
5971	Jewelry Stores - Establishments primarily engaged in the retail sale of any combination of the lines of jewelry, sterling and plated silverware, watches, and clocks.	Yellow Pages
5982	Coal and Wood Dealers - Establishments primarily engaged in the retail sale of coal and wood.	Yellow Pages
5983	Fuel Oil and Bottled Gas Dealers - Establishments primarily engaged in the retail sale of fuel oil and/or liquefied petroleum gas (bottled gas).	Yellow Pages
5992	Florists - Establishments primarily engaged in the retail sale of cut flowers and growing plants.	Yellow Pages
5996	Camera and Photographic Supply Stores - Establishments primarily engaged in the retail sale of cameras, films, and other photographic supplies and equipment.	Yellow Pages
6020	Banks - Institutions which are engaged in deposit banking or closely related functions.	D & B
6120	Savings and Loan Associations - Savings and loan associations, and building and loan associations.	Yellow Pages
7011	Hotels and Motels - Commercial establishments, known as hotels, motor-hotels, or motels, primarily engaged in providing lodging for the general public.	Yellow Pages
7200	Personal Services - Establishments primarily engaged in providing services generally involving the care of the person or his apparel such as laundries, cleaning and dyeing plants, photographic studios, barber and beauty shops, cleaning and pressing shops, and funeral homes.	Yellow Pages
7300	Business Services - Establishments rendering services to business enterprises such as advertising agencies, advertising services, photocopying and duplicating services, stenographic services, telephone answering services, temporary help, employment agencies, management and consulting services, detective agencies, window cleaning and janitorial services, and exterminating services.	Yellow Pages

SIC Code	Definition	Source
7534	Tire Retreading and Repair Shops - Establishments primarily engaged in repairing and retreading automotive tires.	Yellow Pages
7538	Automobile Repair Shops - Establishments primarily engaged in general repair and body work on automobiles . Includes paint shops.	Yellow Pages
7832	Amusement and Recreation Services - Establishments whose primary function is to provide amusement or entertainment on payment of a fee or admission charge . Includes motion picture theaters and drive-in theaters, bowling alleys, pool halls, golf courses and tennis courts.	Yellow Pages
8111	Lawyers - Individuals offering legal services on a contract or fee basis . Includes those practicing within a law firm.	Yellow Pages
8931	Accountants - Individuals and firms primarily engaged in furnishing accounting and auditing services.	Yellow Pages
*9991	Postal Receipts - Information obtained from Revenues and Classes of Post Offices, July 1, 1970, United States Government Printing Office.	
*9992	Commercial Air Freight - Information obtained from Airport Activity Statistics of Certified Route Air Carriers, June 30, 1970, Department of Transportation, Federal Aviation Administration, Civil Aeronautics Board.	
*9993	Highways - Information obtained from highway maps of the area rating interstate highways greater than state and county highways.	
*9300	County Seats - Rand McNally Commercial Directory, 1970.	
*9994	Population - Rand McNally Commercial Directory, 1970.	

[+] Dun and Bradstreet, Inc., Reference Book: March, 1972, New York: Dun and Bradstreet, 1972.

APPENDIX "B"

LIST OF 24 HEALTH MANPOWER AND HEALTH FACILITIES VARIABLES USED TO IDENTIFY THE HEALTH SYSTEM

This appendix is a list of the 24 health manpower and health facilities variables used to identify the health system in the intermountain region. Each variable includes description, when appropriate, and each variable includes the data source used.

HEALTH VARIABLES

Variables	Source
HEALTH MANPOWER	
Dental Hygienists	State Licensing Rosters
Dentists	American Dental Association Directory
Licensed Practical Nurses	State Licensing Rosters
Optometrists	State Licensing Rosters
Pharmacists	State Licensing Rosters
Physicians and Osteopaths	American Medical Association Directory (Physicians), State Licensing Rosters (Osteopaths)
Physical Therapists	State Licensing Rosters
Podiatrists	State Licensing Rosters
Veterinarians	State Licensing Rosters
HEALTH INSTITUTIONS	
Number of nursing homes	State Health Department Publications
Number of beds in nursing homes	State Health Department Publications
Number of hospitals, includes federal hospitals	American Hospital Association *Guide*
Number of beds in hospitals	American Hospital Association *Guide*
Hospital occupancy rate*	American Hospital Association *Guide*
Hospital personnel**	American Hospital Association *Guide*

*Defined as ratio of average daily census to the average number of beds maintained during the 12-month reporting period.

**Defined as total personnel, excludes trainees, private duty nurses, and volunteers; includes full-time equivalents for part-time personnel.

HEALTH VARIABLES

Variables	Source
HOSPITAL FACILITIES	
Open heart surgery facilities and histopathology laboratory	American Hospital Association _Guide_
Pharmacy with full-time registered pharmacist	American Hospital Association _Guide_
X-ray therapy	American Hospital Association _Guide_
Radium therapy, cobalt therapy, diagnostic radioisotope, and therapeutic radioisotope facilities	American Hospital Association _Guide_
Inhalation therapy department	American Hospital Association _Guide_
Inpatient renal dialysis and outpatient renal dialysis facilities	American Hospital Association _Guide_
Occupational therapy department, rehabilitation inpatient department, rehabilitation outpatient department, and social work department	American Hospital Association _Guide_
Emergency department	American Hospital Association _Guide_

APPENDIX "C"

A LISTING OF THE 538 COMMUNITIES IN THE STUDY REGION BY THE CENTRALITY INDEX

This appendix is a listing of the 538 communities and an accompanying column with the population of each community.

This appendix also includes the health index for each community in the study region.

Finally, the communities are ranked in descending order on the centrality index for the first six hierarchies only. Hierarchy seven has not been strictly ranked since the values of the centrality index are close to zero for most of the communities.

538 CITIES ARE RANKED INTO 7 GROUPS BASED ON
THE CENTRALITY INDEX FROM 17 SELECTED VARIABLES

GROUP 1

ID	CITY		POP	CENTRALITY INDEX	HEALTH INDEX
31	DENVER	C	999999	5.0012417	9.3977852

GROUP 2

ID	CITY		POP	CENTRALITY INDEX	HEALTH INDEX
651	SALTLAKE C	U	557635	2.6214581	3.1379128

GROUP 3

ID	CITY		POP	CENTRALITY INDEX	HEALTH INDEX
312	BILLINGS	M	61581	.5846790	.5746168
642	OGDEN	U	116945	.5777737	.7132918
647	PROVO	U	119451	.5166960	.8387790

GROUP 4

	CITY		POP	CENTRALITY INDEX	HEALTH INDEX
827	CASPER	W	39400	.3894795	.3126797
14	BOULDER	C	69279	.3869109	.5807378
559	RAPID CITY	S	43836	.3489432	.5642818
224	IDAHOFALLS	I	35776	.3119363	.3561957
243	POCATELLO	I	40036	.2943655	.5227992
45	FT COLLINS	C	43337	.2898801	.4798062
63	GREELEY	C	40129	.2705990	.4265206
829	CHEYENNE	W	40000	.2629849	.5523456

GROUP 5

ID	CITY		POP	CENTRALITY INDEX	HEALTH INDEX
98	LONGMONT	C	23209	.1833664	.2505936
440	SCOTTSBLUF	N	14507	.1711982	.3160567
315	BOZEMAN	M	18670	.1662389	.2360501
631	LOGAN	U	22333	.1441042	.1942776
99	LOVELAND	C	16220	.1265901	.1815755
896	LARAMIE	W	24700	.1240875	.1747245
956	SHERIDAN	W	10800	.1134501	.2278514
142	STERLING	C	10636	.0981488	.2272663
945	ROCK SPGS	W	12100	.0954183	.1308116
57	GLENWOODSP	C	4106	.0873412	.0727686
401	ALLIANCE	N	6862	.0828684	.1078426
46	FT MORGAN	C	7594	.0806381	.0744516
657	VERNAL	U	3908	.0761402	.0181365
208	BLACKFOOT	I	8716	.0748926	.1877385
942	RIVERTON	W	7995	.0746413	.0648617

41	ESTES PARK	C	1616	.0706671	.0233124
347	LIVINGSTON	M	6883	.0679029	.0749742
939	RAWLINS	W	7855	.0656501	.0918477
441	SIDNEY	N	6403	.0656297	.1546060
832	CODY	W	5161	.0655669	.0911520
979	WORLAND	W	5055	.0628257	.0865262

GROUP 6	ID	CITY		POP	CENTRALITY INDEX	HEALTH INDEX
	245	REXBURG	I	8272	.0573991	.0547677
	503	BELLEFCHE	S	4236	.0563135	.0781866
	850	EVANSTON	W	4462	.0533408	.1226920
	936	POWELL	W	4807	.0525357	.0518243
	515	DEADWOOD	S	2409	.0520822	.0682249
	27	CRAIG	C	4205	.0515969	.0588524
	410	CHADRON	N	5921	.0510043	.0614265
	968	TORRINGTON	W	4237	.0491142	.0778556
	895	LANDER	W	7125	.0480578	.0838286
	861	GILLETTE	W	7194	.0476318	.0706481
	568	STURGIS	S	4536	.0470587	.1931133
	884	JACKSON	W	3196	.0465646	.0407412
	17	BRUSH	C	3377	.0441808	.0572896
	424	KIMBLE	N	3680	.0434654	.0363854
	244	PRESTON	I	3310	.0418227	.0226634
	866	GREENRIVER	W	4196	.0411825	.0046478
	416	GERING	N	5639	.0409326	.0357896
	235	MONTPELIER	I	2604	.0405366	.0091119
	417	GORDAN	N	2106	.0382381	.0477490
	529	HOT SPRINGS	S	4434	.0371228	.1571179
	650	ROOSEVELT	U	2005	.0361758	.0383717
	567	SPEARFISH	S	4661	.0360387	.0641457
	141	STEAMBOAT S	C	2340	.0356374	.0496719
	367	RED LODGE	M	1844	.0355871	.0478323
	966	THERMOPLIS	W	3063	.0328478	.0718301
	620	HEBER	U	3245	.0327195	.0452927
	843	DOUGLAS	W	2677	.0328101	.0482217
	161	YUMA	C	2259	.0326000	.0317021
	159	WRAY	C	1953	.0325489	.0419064
	249	ST ANTHONY	I	2877	.0322569	.0251453
	133	RIFLE	C	2150	.0314549	.0423028
	976	WHEATLAND	W	2498	.0312253	.0485281
	340	HARDIN	M	2733	.0300822	.0411030
	820	BUFFALO	W	3394	.0280816	.0485182
	514	CUSTER	S	1597	.0279081	.0442960
	903	LOVELL	W	2371	.0276473	.0330638
	802	AFTON	W	1290	.0273228	.0269158
	533	LEAD	S	5420	.0253528	.0602271
	924	NEWCASTLE	W	3432	.0242136	.0368194
	246	RIGBY	I	2293	.0243223	.0130138

	60	GRANBY	C	554	.0239858	.0064895
	346	LAUREL	M	4454	.0236552	.0168873
	87	JULESBURG	C	1578	.0237085	.0352003
	889	KEMMERER	W	2292	.0225549	.0236191
	534	LEMMON	S	1997	.0221925	.0320243
	148	VAIL	C	484	.0218040	.0113315
	652	SMITHFIELD	U	3342	.0215950	.0072081
	434	MITCHELL	N	1842	.0206367	.0152343
	407	BRIDGEPORT	N	1490	.0205651	.0277746
	311	BIG TIMBER	M	1592	.0201584	.0304053
	322	COLUMBUS	M	1175	.0195018	.0338759
	74	HOLYOKE	C	1640	.0197017	.0408889
	252	SODA SPGS	I	2977	.0188236	.0261320
	933	PINE BLUFF	W	937	.0183884	.0007937
	155	WINDSOR	C	1564	.0184266	.0127152
	79	IDAHO SPGS	C	2003	.0180543	.0088371
	1	AKRON	C	1775	.0181107	.0702016
	216	DRIGGS	I	727	.0180798	.0261642
	383	W YELLWSTN	M	756	.0174377	.0004799

GROUP 7	ID	CITY		POP	CENTRALITY INDEX	HEALTH INDEX
	439	RUSHVILLE	N	1137	.0162153	.0215229
	251	SHELLEY	I	2614	.0154373	.0054366
	904	LUSK	W	1495	.0147094	.0284771
	429	LYMAN	N	561	.0146814	.0010017
	622	HOOPER	U	300	.0144005	.0016804
	437	OSHKOSH	N	1067	.0144964	.0444357
	36	EATON	C	1389	.0138849	.0053199
	373	SHERIDAN	M	636	.0140780	.0075068
	106	MEEKER	C	1597	.0138495	.0345572
	867	GREYBULL	W	1953	.0136827	.0329909
	435	MORRIL	N	937	.0134578	.0036966
	61	GRAND LAKE	C	189	.0132509	.0009463
	404	BAYARD	N	1338	.0131484	.0068358
	644	PARK CITY	U	1193	.0127324	.0011470
	411	CHAPPELL	N	1204	.0121423	.0072904
	934	PINEDALE	W	948	.0119904	.0063221
	150	WALDEN	C	907	.0116034	.0051631
	15	BRECKENRDG	C	548	.0116359	.0012182
	144	STRASBURG	C	600	.0115380	.0005353
	69	HAXTON	C	899	.0112105	.0384102
	412	CRAWFORD	N	1291	.0113472	.0488209
	50	FRISCO	C	471	.0113548	.0006461
	610	COALVILLE	U	864	.0110918	.0023128
	811	BASIN	W	1145	.0111637	.0109461
	101	LYONS	C	958	.0104042	.0059611
	11	BERTHOUD	C	1446	.0104387	.0151949
	93	KREMMLING	C	764	.0104499	.0057119

636	MORGAN	U	1586	.0102347	.0062077
130	RANGELY	C	1591	.0100320	.0269035
951	SARATOGA	W	1181	.0093734	.0038441
32	DILLION	C	182	.0090814	.0079817
35	EAGLE	C	790	.0088468	.0010017
844	DUBOIS	W	898	.0089558	.0006645
962	SUNDANCE	W	1056	.0085471	.0238104
203	ASHTON	I	1187	.0086796	.0210760
517	EDGEMONT	S	1174	.0083068	.0050343
112	NEW CASTLE	C	499	.0084846	.0008413
422	HEMINGFORD	N	734	.0083520	.0057319
612	DUCHESNE	U	1094	.0083096	.0005353
863	GLENROCK	W	1515	.0083612	.0017769
378	THREEFORKS	M	1188	.0082171	.0068404
317	BROADUS	M	799	.0081958	.0019901
969	UPTON	W	987	.0078525	.0001661
421	HAY SPRNGS	M	682	.0075748	.0087396
846	EDGERTON	W	350	.0067390	.0005218
201	ABERDEEN	I	1542	.0068101	.0038678
869	GUERNSEY	W	793	.0064565	.0000554
572	WALL	S	786	.0064331	.0012420
309	BELGRADE	M	1307	.0060386	.0064640
331	ENNIS	M	501	.0059215	.0240863
542	NEWELL	S	664	.0056253	.0030266
22	CENTRALCITY	C	228	.0056099	.0007067
248	ROBERTS	I	393	.0054375	.0005353
305	ASHLAND	M	150	.0056134	.0000554
53	GILCREST	C	382	.0057196	.0000554
912	MEDICINE B	W	455	.0054871	.0001108
222	GRACE	I	826	.0055907	.0041237
814	BIG PINEY	W	570	.0054448	.0023223
108	MILLIKEN	C	720	.0051845	.0003060
6	AULT	C	841	.0053288	.0025673
899	LINGLE	W	446	.0051997	.0009044
52	GEORGETOWN	C	542	.0051114	.0024492
75	H SULPHUR S	C	220	.0050227	.0000554
964	TENSLEEP	W	320	.0047130	.0001661
137	SILT	C	434	.0049119	.0003192
70	HAYDEN	C	763	.0049129	.0007568
443	WHITECLAY	N	90	.0048173	.0004245
42	EVANS	C	2570	.0046880	.0024992
55	GILMAN	C	350	.0045455	.0000554
316	BRIDGER	M	717	.0046124	.0028364
521	FAITH	S	576	.0044002	.0057885
507	BUFFALO	S	393	.0044647	.0004245
205	BANCROFT	I	366	.0043279	.0002215
215	DOWNEY	I	586	.0041193	.0271877
301	ABSAROKEE	M	600	.0040943	.0034080
336	GARDINER	M	650	.0041482	.0005222
135	SEDGWICK	C	208	.0042112	.0019770

913	MEETEETSE	W	459	.0040692	.0003691
918	MOORCROFT	W	981	.0041193	.0000554
386	WORDEN	M	250	.0041444	.0021193
957	SHOSHONI	W	562	.0040451	.0005775
627	KAMAS	U	806	.0040874	.0011921
88	KEENESBURG	C	427	.0041577	.0035057
20	CARBONDALE	C	726	.0040275	.0100274
230	LAVA HOT SP	I	516	.0038886	.0048464
625	HYRUM	U	2340	.0038316	.0051852
348	LODGEGRASS	M	806	.0036741	.0000554
433	MINATARE	N	939	.0037397	.0056264
72	HIDEAWAY PK	C	200	.0037434	.0024438
48	FRASER	C	221	.0037630	.0000554
527	HILL CITY	S	389	.0035396	.0004168
2	ALLENSPARK	C	40	.0035323	.0007618
262	VICTOR	I	241	.0034502	.0002769
86	JOHNSTOWN	C	1191	.0034657	.0057089
630	LEWISTON	U	1244	.0034157	.0021193
323	COOKE CITY	M	30	.0032012	.0000000
40	ERIE	C	1090	.0033489	.0062642
128	PLATTEVILL	C	683	.0032919	.0033248
352	MANHATTAN	M	816	.0033587	.0024763
649	RICHMOND	U	1000	.0032668	.0038006
228	ISLANDPARK	I	136	.0031382	.0000000
833	COKEVILLE	W	440	.0029203	.0000554
116	OAK CREEK	C	492	.0030429	.0034317
616	FT DUCHSNE	U	200	.0030276	.0000000
381	VIRGINIA C	M	149	.0031094	.0003691
325	CROWAGENCY	M	600	.0030089	.0503627
414	DIX	N	342	.0030059	.0000000
634	MIDWAY	U	804	.0029705	.0004299
345	LAME DEER	M	300	.0031097	.0001108
420	HARRISON	N	377	.0029203	.0003192
380	TWINBRIDGES	M	613	.0028190	.0033526
426	LEWELLEN	N	376	.0028535	.0048504
240	PARIS	I	615	.0028790	.0004799
146	TIMNATH	C	177	.0027467	.0000554
109	MINTURN	C	706	.0029105	.0002084
158	WOODROW	C	20	.0027147	.0000000
255	SUGAR CITY	I	617	.0027467	.0005830
438	POTTER	N	356	.0024691	.0001661
428	LODGEPOLE	N	407	.0026045	.0004168
111	NEDERLAND	C	492	.0026547	.0023700
855	FT WASHKIE	W	300	.0026645	.0003323
247	RIRIE	I	575	.0026547	.0001661
335	GALLATIN G	M	200	.0024879	.0005276
344	JOLIET	M	412	.0025951	.0013212
551	PINE RIDGE	S	2768	.0026680	.0533234
543	N UNDRWOOD	S	416	.0025381	.0064046
369	ROBERTS	M	300	.0026645	.0004168

92	KITTREDGE	C	50	.0024309	.0007306
154	WIGGINS	C	400	.0023138	.0003746
62	GRANDVALLY	C	270	.0024057	.0000000
326	CUSTER	M	350	.0024308	.0000554
124	PHIPPSBURG	C	150	.0024338	.0000000
891	LA BARGE	W	500	.0024057	.0000554
30	DEER TRAIL	C	374	.0023206	.0000000
313	BIRNEY	M	20	.0021529	.0013441
886	KAYCEE	W	272	.0020997	.0000554
905	LYMAN	W	643	.0020359	.0001108
56	GLEN HAVEN	C	25	.0021749	.0000000
849	ENCAMPMENT	W	321	.0020834	.0000000
621	HENEFER	U	446	.0021529	.0000000
872	HANNA	W	460	.0020620	.0002400
862	GLENDO	W	210	.0021499	.0000554
126	PINE	C	35	.0021902	.0008229
646	PROVIDENCE	U	1608	.0021181	.0013948
973	WAMSUTTER	W	139	.0021499	.0000000
118	OTIS	C	521	.0021499	.0006121
19	BYERS	C	500	.0020010	.0033870
131	REDCLIFF	C	621	.0018690	.0000000
408	BROADWATER	N	141	.0018371	.0002084
219	FRANKLIN	I	402	.0018025	.0003691
259	TETON	I	390	.0018690	.0004168
554	PRAIRIE CT	S	50	.0018690	.0000554
303	ALDER	M	100	.0018690	.0002638
132	REDFEATHER	C	50	.0018940	.0000000
841	DIAMONDVIL	W	485	.0018381	.0000554
59	GOULD	C	40	.0018371	.0000000
12	BLACKHAWK	C	217	.0018940	.0003060
260	TETONIA	I	176	.0018120	.0000000
413	DALTON	N	354	.0018371	.0003507
82	ILIFF	C	193	.0016953	.0000000
531	KEYSTONE	S	500	.0016033	.0000554
840	DEVILS TOW	W	10	.0016131	.0000000
838	DAYTON	W	396	.0015881	.0026882
160	YAMPA	C	286	.0016131	.0004168
641	OAKLEY	U	265	.0016131	.0000000
83	INDIANHILL	C	700	.0015812	.0014793
509	CAMP CROOK	S	150	.0016131	.0000000
880	HULETT	W	318	.0015881	.0001108
151	WARD	C	32	.0016382	.0000000
825	BYRON	W	397	.0016131	.0000554
643	PARADISE	U	399	.0015881	.0000554
575	WHITEWOOD	S	689	.0016702	.0053832
917	MONETA	W	10	.0016382	.0000000
618	GOSHEN	U	459	.0015881	.0007229
29	DACONO	C	360	.0016102	.0006461
26	COWDREY	C	60	.0016131	.0000000
965	THAYNE	W	195	.0016131	.0000554

10	BENNETT	C	613	.0017771	.0006806
342	HUNTLEY	M	250	.0015812	.0004853
33	DINOSAUR	C	247	.0015851	.0000554
360	PARK CITY	M	300	.0013573	.0003192
837	DANIEL	W	125	.0015562	.0001108
910	MANDERSON	W	117	.0013573	.0001108
77	HUDSON	C	518	.0015532	.0001530
333	FISHTAIL	M	80	.0013573	.0000554
922	MOUNT VIEW	W	500	.0015562	.0000554
34	DRAKE	C	100	.0013573	.0013441
210	CHESTER	I	100	.0013573	.0000000
320	CAMERON	M	10	.0013573	.0000554
49	FREDERICK	C	696	.0014894	.0002084
90	KERSEY	C	474	.0015532	.0002215
888	KELLY	W	25	.0013573	.0000554
28	CROOK	C	199	.0015532	.0004168
935	POWDER RVR	W	50	.0013573	.0000000
73	HILLROSE	C	121	.0015216	.0005222
619	HANNA	U	25	.0013573	.0000000
258	TERRETON	I	50	.0013322	.0000000
153	WELLINGTON	C	691	.0012974	.0012450
853	FT BRIDGER	W	150	.0013003	.0000554
156	WINTERPARK	C	50	.0011236	.0000000
80	IDALIA	C	85	.0013293	.0001530
362	PONY	M	150	.0013003	.0003192
656	TRENTON	U	390	.0013003	.0003192
368	REED POINT	M	100	.0013322	.0000000
632	MANILA	U	226	.0013322	.0001661
357	NORRIS	M	25	.0013322	.0000554
221	GEORGETOWN	I	421	.0013322	.0000554
804	ALCOVA	W	80	.0013322	.0000554
835	COWLEY	W	366	.0013322	.0004245
813	BIG HORN	W	200	.0013003	.0006883
24	CONNIFER	C	150	.0012654	.0015559
661	WOODRUFF	U	173	.0013003	.0000554
37	ECKLEY	C	193	.0010764	.0003060
354	MELVILLE	M	15	.0010764	.0000000
253	SQUIRREL	I	5	.0010764	.0000554
211	CLIFTON	I	137	.0010764	.0000000
234	MONTEVIEW	I	10	.0010764	.0001108
553	PORCUPINE	S	25	.0010764	.0000000
97	LIVERMORE	C	20	.0010734	.0039541
68	HAMILTON	C	15	.0010764	.0000000
212	CONDOR	I	200	.0010764	.0000000
576	WOUNDED KN	S	50	.0010764	.0000000
847	ELK MOUNT	W	127	.0010764	.0000000
44	FLEMING	C	349	.0010165	.0004722
372	SHEPHERD	M	100	.0010764	.0005353
327	DECKER	M	5	.0010764	.0000554
504	BISON	S	406	.0010484	.0033870

379	TRIDENT	M	100	.0010764	.0000000
365	PRYOR	M	50	.0010764	.0001530
384	WILLOW CRK	M	150	.0010764	.0002638
801	ACME	W	100	.0010764	.0000000
834	CORA	W	5	.0010764	.0000000
510	CAPUTA	S	40	.0010764	.0000000
629	LAPOINT	U	200	.0010764	.0001530
819	BOULDER	W	75	.0010764	.0000000
604	BLUEBELL	U	30	.0010764	.0001530
535	LODGEPOLE	S	20	.0010764	.0000000
961	STORY	W	400	.0010415	.0001661
91	KIRK	C	100	.0010764	.0000000
4	ANTON	C	50	.0010165	.0000000
836	CROWHEART	W	10	.0010764	.0001530
927	OPAL	W	34	.0010764	.0000000
954	SHAWNEE	W	25	.0010764	.0000000
906	LYSITE	W	50	.0010764	.0000000
885	JAY EM	W	15	.0010764	.0000000
157	WOLCOTT	C	35	.0010764	.0000000
356	MOLT	M	20	.0010764	.0000000
923	NATRONA	W	5	.0010764	.0000000
361	POMPEYS PL	M	100	.0010764	.0000000
7	AVON	C	35	.0010764	.0000000
308	BELFRY	M	250	.0010165	.0013995
639	NEOLA	U	400	.0010764	.0000554
319	BUSBY	M	300	.0010764	.0000000
226	IONA	I	890	.0010764	.0003192
147	TOPONAS	C	70	.0010764	.0000000
256	SWAN LAKE	I	135	.0010764	.0000000
546	OGLALA	S	50	.0010764	.0001530
371	ST XAVIER	M	100	.0010764	.0000554
637	MT HOME	U	50	.0010764	.0000000
242	PINGREE	I	100	.0010764	.0001530
18	BURNS	C	30	.0010764	.0029624
615	ELBERTA	U	50	.0010764	.0000554
366	RAPELJE	M	100	.0010764	.0000554
430	MCGREW	N	79	.0010764	.0001530
606	BRIDGELAND	U	20	.0010764	.0000000
562	REVA	S	5	.0010764	.0000000
645	PEOA	U	130	.0010764	.0000000
952	SAVERY	W	25	.0010764	.0000000
409	BUSHNELL	N	211	.0010165	.0002638
931	PARKMAN	W	25	.0010764	.0013441
658	WALLSBURG	U	211	.0010764	.0000554
516	DENBY	S	10	.0010764	.0000000
633	MENDON	U	345	.0010764	.0073114
377	SPRINGDALE	M	50	.0010764	.0000000
958	SINCLAIR	W	445	.0010484	.0004168
653	TABIONA	U	125	.0010764	.0000554
938	RANCHESTER	W	208	.0010165	.0001108

613	ECHO	U	60	.0010415	.0000000
370	ROSCOE	M	50	.0010764	.0000000
548	ORAL	S	60	.0010764	.0000000
318	BROADVIEW	M	123	.0007356	.0001108
659	WELLSVILLE	U	1267	.0007356	.0029888
232	MCCAMMON	I	623	.0007925	.0002084
506	BOX ELDER	S	607	.0007925	.0003614
617	GARDEN CTY	U	134	.0008176	.0000000
879	HUDSON	W	381	.0007857	.0000000
648	RANDOLPH	U	500	.0008176	.0004299
418	GURLEY	N	233	.0007356	.0001108
385	WILSALL	M	200	.0007925	.0007437
944	ROCK RIVER	W	344	.0007925	.0000000
915	MIDWEST	W	825	.0007925	.0002769
218	FIRTH	I	362	.0008176	.0007229
304	ALZADE	M	50	.0007925	.0000000
95	LAPORTE	C	800	.0007925	.0010974
427	LISCO	N	150	.0007925	.0000554
920	MORAN	W	10	.0007925	.0000000
85	JOES	C	110	.0008176	.0000000
375	SILVERGATE	M	20	.0008176	.0003691
66	GYPSUM	C	420	.0008176	.0013995
117	ORCHARD	C	75	.0005116	.0000000
526	HERMOSA	S	150	.0005618	.0000000
830	CHUGWATER	W	187	.0005367	.0000000
145	TABERNASH	C	250	.0005367	.0000000
823	BURNS	W	185	.0004797	.0002638
25	COPE	C	110	.0005367	.0000000
5	ATWOOD	C	100	.0005116	.0001108
828	CENTENNIAL	W	100	.0005618	.0002084
202	ARIMO	I	252	.0005367	.0003746
100	LUCERNE	C	75	.0005367	.0000000
432	MELBETA	N	124	.0005367	.0000000
334	FROMBERG	M	364	.0005367	.0000554
250	ST CHARLES	I	200	.0005367	.0000000
119	OVID	C	463	.0005367	.0006752
544	NISLAND	S	157	.0005116	.0001108
854	FT LARAMIE	W	197	.0005116	.0000000
628	LAKETOWN	U	208	.0005116	.0001530
839	DEAVER	W	112	.0005367	.0001530
808	BACGS	W	146	.0005367	.0000554
626	JENSEN	U	300	.0005116	.0000000
512	CENTRAL CTY	S	188	.0005618	.0000554
78	HYGIENE	C	250	.0005367	.0000000
387	WYOLA	M	100	.0005367	.0000000
364	PRAY	M	0	.0005618	.0000000
623	HUNTSVILLE	U	553	.0005618	.0026231
423	HENRY	N	147	.0004797	.0000000
900	LITTL AMER	W	60	.0005367	.0000000
845	DWYER	W	20	.0002809	.0000554

105	MEAD	C	195	.0002558	.0000000
121	PAOLI	C	52	.0002558	.0000000
54	GILL	C	140	.0002558	.0002638
812	BEULAH	W	65	.0002809	.0000000
937	RALSTON	W	100	.0002558	.0000554
893	LAMONT	W	100	.0002558	.0000000
38	EDWARDS	C	10	.0002558	.0000000
136	SEVERANCE	C	59	.0002558	.0000000
257	SWAN VALLY	I	235	.0002809	.0003614
113	NEW RAYMER	C	68	.0002558	.0000000
919	MOOSE	W	50	.0002558	.0000000
138	SILVERPLUM	C	164	.0002558	.0000000
13	BOND	C	80	.0002558	.0000000
550	PIEDMONT	S	200	.0002558	.0002084
928	OSAGE	W	350	.0002558	.0013441
306	BALLANTINE	M	350	.0002558	.0003192
624	HYDE PARK	U	1025	.0002558	.0029651
890	KINNEAR	W	50	.0002558	.0013441
655	THISTLE	U	50	.0002558	.0000000
71	HEREFORD	C	75	.0002809	.0000554
237	NEWDALE	I	267	.0002558	.0005907
51	GALETON	C	170	.0002558	.0000554
43	FIRESTONE	C	570	.0002809	.0001108
444	WHITNEY	N	82	.0002558	.0000554
114	NIWOT	C	200	.0002558	.0002638
960	SMOOT	W	100	.0002558	.0000000
921	MORTON	W	5	.0002809	.0000000
204	ATOMIC CTY	I	24	.0002558	.0000000
545	OELRICHS	S	94	.0002558	.0000000
972	WALCOTT	W	20	.0002558	.0000000
129	RAND	C	15	.0002558	.0000000
122	PARSHALL	C	100	.0003193	.0000554
882	HYATTVILLE	W	100	.0002809	.0001108
376	SILVERSTAR	M	75	.0002809	.0002638
932	PAVILLION	W	181	.0002558	.0001661
330	EMIGRANT	M	25	.0002809	.0000000
887	KEELINE	W	30	.0002558	.0000000
3	AMHERST	C	100	.0002558	.0000000
236	MORELAND	I	300	.0002558	.0003691
824	BURRIS	W	10	.0002809	.0000000
573	WASTA	S	127	.0002558	.0000000
233	MENAN	I	545	.0002558	.0005907
225	INKOM	I	522	.0002809	.0374915
894	LANCECREEK	W	175	.0002558	.0001530
831	CLEARMONT	W	141	.0002558	.0000000
875	HAWK SPGS	W	100	.0002809	.0000554
213	DAYTON	I	198	.0002558	.0001108
640	NEWTON	U	444	.0002558	.0005772
982	YODER	W	101	.0002809	.0000554
892	LAGRANGE	W	189	.0002558	.0000554

104	MAYBELL	C	145	.0002809	.0000000
541	NEMO	S	65	.0002809	.0002804
974	WAPITI	W	25	.0002809	.0000000
803	ALBIN	W	118	.0000000	.0000554
805	ALVA	W	50	.0000000	.0000000
614	EDEN	U	200	.0000000	.0005353
16	BRIGGSDALE	C	75	.0000000	.0003060
261	UCON	I	664	.0000000	.0005407
9	BELLVUE	C	200	.0000000	.0030496
540	MUD BUTTE	S	10	.0000000	.0000000
84	JAMESTOWN	C	185	.0000000	.0000554
826	CARPENTER	W	100	.0000000	.0001108
241	PARKER	I	266	.0000000	.0000554
539	MEADOW	S	25	.0000000	.0000000
563	ROCHFORD	S	90	.0000000	.0000000
350	MCALLISTER	M	10	.0000000	.0001661
561	REDOWL	S	10	.0000000	.0000000
107	MERINO	C	260	.0000000	.0004853
508	BUFFALOGAP	S	155	.0000000	.0000000
206	BASALT	I	349	.0000000	.0002084
519	ENNING	S	15	.0000000	.0000000
609	CLARKSTON	U	420	.0000000	.0002084
881	HUNTLEY	W	80	.0000000	.0000000
817	BONDURANT	W	100	.0000000	.0000000
566	SMITHWICK	S	40	.0000000	.0000000
310	BIDDLE	M	25	.0000000	.0000000
264	WESTON	I	230	.0000000	.0000554
81	IDLE DALE	C	350	.0000000	.0007782
217	FELT	I	35	.0000000	.0000000
571	VALE	S	115	.0000000	.0000554
916	MILLS	W	1724	.0002239	.0005698
102	MCCOY	C	25	.0000000	.0000000
328	EDGAR	M	130	.0000000	.0000554
532	KYLE	S	70	.0000000	.0000554
343	JEFFERS	M	60	.0000000	.0000000
227	IRWIN	I	228	.0000000	.0000554
842	DIXON	W	72	.0000000	.0000000
238	OVID	I	145	.0000000	.0000554
231	LORENZO	I	100	.0000000	.0004431
94	LAIRD	C	150	.0000000	.0016633
930	OTTO	W	50	.0000000	.0000000
125	PIERCE	C	452	.0002239	.0000000
505	BLACK HAWK	S	350	.0002239	.0021855
810	BANNER	W	40	.0000000	.0002638
570	UNION CNTR	S	35	.0000000	.0000000
635	MILLVILLE	U	441	.0000000	.0005907
415	ELLSWORTH	N	15	.0000000	.0000000
123	PEETZ	C	186	.0000000	.0001530
638	MYTON	U	322	.0002239	.0002084
134	ROGGEN	C	50	.0000000	.0000000

96	LINDON	C	40	.0000000	.0000000
864	GRANGER	W	137	.0000000	.0000000
557	QUINN	S	105	.0000000	.0034404
607	CACHE JUNCT	U	100	.0000000	.0000000
140	SNYDER	C	150	.0000000	.0001530
856	FRANNIE	W	139	.0000000	.0000000
871	HAMILTON DM	W	100	.0000000	.0000554
564	ST ONGE	S	80	.0000000	.0000554
874	HAT CREEK	W	5	.0000000	.0000000
940	RECLUSE	W	10	.0000000	.0000554
876	HILAND	W	10	.0000000	.0000000
877	HILLSDALE	W	80	.0000000	.0000000
442	SUNOL	N	100	.0000000	.0000000
870	GRASSCREEK	W	115	.0000000	.0000000
152	WELDON	C	150	.0000000	.0003060
501	ARDMORE	S	14	.0000000	.0000000
552	PLAINVIEW	S	5	.0000000	.0000000
601	ALTAMONT	U	129	.0002239	.0002084

APPENDIX "D"

A LISTING OF THE 538 COMMUNITIES IN THE STUDY REGION BY THE HEALTH INDEX

This appendix is a listing of the 538 communities and an accompanying column with the population of each community.

This appendix also includes the centrality index for each community in the study region.

Finally, the communities are ranked in descending order on the health index for the first six hierarchies only. Hierarchy seven has not been strictly ranked since the values of the health index are close to zero for most of the communities.

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        538 CITIES ARE RANKED INTO  7 GROUPS BASED ON
        THE HEALTH INDEX FROM 24 SELECTED VARIABLES


GROUP 1    ID        CITY            POP       HEALTH        CENTRALITY
                                                INDEX          INDEX

           31    DENVER      C     999999    9.3977852      5.0012417

GROUP 2    ID        CITY            POP       HEALTH        CENTRALITY
                                                INDEX          INDEX

          651    SALTLAKE C  U     557635    3.1379128      2.6214581

GROUP 3    ID        CITY            POP       HEALTH        CENTRALITY
                                                INDEX          INDEX

          647    PROVO       U     119451     .8387790       .5166960
          642    OGDEN       U     116945     .7132918       .5777737

GROUP 4    ID        CITY            POP       HEALTH        CENTRALITY
                                                INDEX          INDEX

           14    BOULDER     C      69279     .5807378       .3869109
          312    BILLINGS    M      61581     .5746168       .5846790
          559    RAPID CITY  S      43836     .5642818       .3489432
          829    CHEYENNE    W      40000     .5523456       .2629849
          243    POCATELLO   I      40036     .5227992       .2943655
           45    FT COLLINS  C      43337     .4798062       .2898801
           63    GREELEY     C      40129     .4265206       .2705990

GROUP 5    ID        CITY            POP       HEALTH        CENTRALITY
                                                INDEX          INDEX

          224    IDAHOFALLS  I      35776     .3561957       .3119363
          440    SCOTTSBLUF  N      14507     .3160567       .1711982
          827    CASPER      W      39400     .3126797       .3894795
           98    LONGMONT    C      23209     .2505936       .1833664
          315    BOZEMAN     M      18670     .2360501       .1662389
          956    SHERIDAN    W      10800     .2278514       .1134501
          142    STERLING    C      10636     .2272663       .0981488
          631    LOGAN       U      22333     .1942776       .1441042
          568    STURGIS     S       4536     .1931133       .0470587
          208    BLACKFOOT   I       8716     .1877385       .0748926
           99    LOVELAND    C      16220     .1815755       .1265901
          896    LARAMIE     W      24700     .1747245       .1240875
          529    HOT SPRINGSS        4434     .1571179       .0371228
          441    SIDNEY      N       6403     .1546060       .0656297

GROUP 6    ID        CITY            POP       HEALTH        CENTRALITY
                                                INDEX          INDEX
```

945	ROCK SPGS	W	12100	.1308116	.0954183
850	EVANSTON	W	4462	.1226920	.0533408
401	ALLIANCE	N	6862	.1078426	.0828684
939	RAWLINS	W	7855	.0918477	.0656501
832	CODY	W	5161	.0911520	.0655669
979	WORLAND	W	5055	.0865262	.0628257
895	LANDER	W	7125	.0838286	.0480578
503	BELLEFCHE	S	4236	.0781866	.0563135
968	TORRINGTON	W	4237	.0778556	.0491142
347	LIVINGSTON	M	6883	.0749742	.0679029
46	FT MORGAN	C	7594	.0744516	.0806381
57	GLENWOODSP	C	4106	.0727686	.0873412
966	THERMOPLIS	W	3063	.0718301	.0328478
861	GILLETTE	W	7194	.0706481	.0476318
1	AKRON	C	1775	.0702016	.0181107
515	DEADWOOD	S	2409	.0682249	.0520822
942	RIVERTON	W	7995	.0648617	.0746413
567	SPEARFISH	S	4661	.0641457	.0360387
410	CHADRON	N	5921	.0614265	.0510043
533	LEAD	S	5420	.0602271	.0253528
27	CRAIG	C	4205	.0588524	.0515969
17	BRUSH	C	3377	.0572896	.0441808
245	REXBURG	I	8272	.0547677	.0573991
551	PINE RIDGE	S	2768	.0533234	.0026680
936	POWELL	W	4807	.0518243	.0525357
325	CROWAGENCY	M	600	.0503627	.0030089
141	STEAMBOAT S	C	2340	.0496719	.0356374
412	CRAWFORD	N	1291	.0488209	.0113472
976	WHEATLAND	W	2498	.0485281	.0312253
820	BUFFALO	W	3394	.0485182	.0280816
843	DOUGLAS	W	2677	.0482217	.0328101
367	RED LODGE	M	1844	.0478323	.0355871
417	GORDAN	N	2106	.0477490	.0382381
620	HEBER	U	3245	.0452927	.0327195
437	OSHKOSH	N	1067	.0444357	.0144964
514	CUSTER	S	1597	.0442960	.0279081
133	RIFLE	C	2150	.0423028	.0314549
159	WRAY	C	1953	.0419064	.0325489
340	HARDIN	M	2733	.0411030	.0300822
74	HOLYOKE	C	1640	.0408889	.0197017
884	JACKSON	W	3196	.0407412	.0465646
69	HAXTON	C	899	.0384102	.0112105
650	ROOSEVELT	U	2005	.0383717	.0361758
225	INKOM	I	522	.0374915	.0002809
329	EKALAKA	M	663	.0372863	.0057016
924	NEWCASTLE	W	3432	.0368194	.0242136
424	KIMBLE	N	3680	.0363854	.0434654
416	GERING	N	5639	.0357896	.0409326
87	JULESBURG	C	1578	.0352003	.0237085
106	MEEKER	C	1597	.0345572	.0138495

322	COLUMBUS	M	1173	.0338759	.0195018
903	LOVELL	W	2371	.0330638	.0276473
867	GREYBULL	W	1953	.0329909	.0136827
534	LEMMON	S	1997	.0320243	.0221925
161	YUMA	C	2259	.0317021	.0326000
311	BIG TIMBER	M	1592	.0304053	.0201584
904	LUSK	W	1495	.0284771	.0147094
407	BRIDGEPORT	N	1490	.0277746	.0205651
215	DOWNEY	I	586	.0271877	.0041193
802	AFTON	W	1290	.0269158	.0273228
130	RANGELY	C	1591	.0269035	.0100320
216	DRIGGS	I	727	.0261642	.0180798
252	SODA SPGS	I	2977	.0261320	.0188236
249	ST ANTHONY	I	2877	.0251453	.0322569
331	ENNIS	M	501	.0240863	.0059215
962	SUNDANCE	W	1056	.0238104	.0085471
889	KEMMERER	W	2292	.0236191	.0225549
41	ESTES PARK	C	1616	.0233124	.0706671
244	PRESTON	I	3310	.0226634	.0418227
439	RUSHVILLE	N	1137	.0215229	.0162153
203	ASHTON	I	1187	.0210760	.0086796

GROUP 7

ID	CITY		POP	HEALTH INDEX	CENTRALITY INDEX
657	VERNAL	U	3908	.0181365	.0761402
346	LAUREL	M	4454	.0168873	.0236552
434	MITCHELL	N	1842	.0152343	.0206367
11	BERTHOUD	C	1446	.0151949	.0104387
246	RIGBY	I	2293	.0130138	.0243223
155	WINDSOR	C	1564	.0127152	.0184266
148	VAIL	C	484	.0113315	.0218040
811	BASIN	W	1145	.0109461	.0111637
20	CARBONDALE	C	726	.0100274	.0040275
235	MONTPELIER	I	2604	.0091119	.0405366
79	IDAHO SPGS	C	2003	.0088371	.0180543
421	HAY SPRNGS	M	682	.0087396	.0075748
32	DILLON	C	182	.0079817	.0090814
373	SHERIDAN	M	636	.0075068	.0140780
633	MENDON	U	345	.0073114	.0010764
411	CHAPPELL	N	1204	.0072904	.0121423
652	SMITHFIELD	U	3342	.0072081	.0215054
378	THREEFORKS	M	1188	.0068404	.0082171
404	BAYARD	N	1338	.0068358	.0131484
60	GRANBY	C	554	.0064895	.0239858
309	BELGRADE	M	1307	.0064640	.0060386
543	N UNDRWOOD	S	416	.0064046	.0025381
934	PINEDALE	W	948	.0063221	.0119904
40	ERIE	C	1090	.0062642	.0033489
636	MORGAN	U	1586	.0062077	.0102347

101	LYONS	C	958	.0059611	.0104042
521	FAITH	S	576	.0057885	.0044002
86	JOHNSTOWN	C	1191	.0057089	.0034657
93	KREMMLING	C	764	.0057119	.0104499
422	HEMINGFORD	N	734	.0057319	.0083520
433	MINATARE	N	939	.0056264	.0037397
251	SHELLEY	I	2614	.0054366	.0154373
575	WHITEWOOD	S	689	.0053832	.0016702
36	EATON	C	1389	.0053199	.0138849
150	WALDEN	C	907	.0051631	.0116034
625	HYRUM	U	2340	.0051852	.0038316
517	EDGEMONT	S	1174	.0050343	.0083068
426	LEWELLEN	N	376	.0048504	.0028535
230	LAVA HOT SP	I	516	.0048464	.0038886
866	GREENRIVER	W	4196	.0046478	.0411825
222	GRACE	I	826	.0041237	.0055907
97	LIVERMORE	C	20	.0039541	.0010734
201	ABERDEEN	I	1542	.0038678	.0068101
649	RICHMOND	U	1000	.0038006	.0032668
435	MORRIL	N	937	.0036966	.0134578
88	KEENESBURG	C	427	.0035057	.0041577
557	QUINN	S	105	.0034404	.0000000
116	OAK CREEK	C	492	.0034317	.0030429
504	BISON	S	406	.0033870	.0010484
301	ABSAROKEE	M	600	.0034080	.0040943
19	BYERS	C	500	.0033870	.0020010
128	PLATTEVILL	C	683	.0033248	.0032919
9	BELLVUE	C	200	.0030496	.0000000
542	NEWELL	S	664	.0030266	.0056253
18	BURNS	C	30	.0029624	.0010764
624	HYDE PARK	U	1025	.0029651	.0002558
659	WELLSVILLE	U	1267	.0029888	.0007356
951	SARATOGA	W	1181	.0028441	.0093734
316	BRIDGER	M	717	.0028364	.0046124
838	DAYTON	W	396	.0026882	.0015881
623	HUNTSVILLE	U	553	.0026231	.0005618
6	AULT	C	841	.0025673	.0053288
42	EVANS	C	2570	.0024992	.0046880
352	MANHATTAN	M	816	.0024763	.0033587
52	GEORGETOWN	C	542	.0024492	.0051114
72	HIDEAWAY PK	C	200	.0024438	.0037434
111	NEDERLAND	C	492	.0023700	.0026547
341	HARRISON	M	275	.0022962	.0000000
814	BIG PINEY	W	570	.0023223	.0054448
610	COALVILLE	U	864	.0023128	.0110918
630	LEWISTON	U	1244	.0021193	.0034157
386	WORDEN	M	250	.0021193	.0041444
135	SEDGWICK	C	208	.0019770	.0042112
317	BROADUS	M	799	.0019901	.0081958
863	GLENROCK	W	1515	.0017769	.0083612

8	BASALT	C	419	.0017265	.0040844
622	HOOPER	U	300	.0016804	.0144005
94	LAIRD	C	150	.0016633	.0000000
24	CONNIFER	C	150	.0015559	.0012654
83	INDIANHILL	C	700	.0014793	.0015812
646	PROVIDENCE	U	1608	.0013948	.0021181
308	BELFRY	M	250	.0013995	.0010165
66	GYPSUM	C	420	.0013995	.0008176
34	DRAKE	C	100	.0013441	.0013573
928	OSAGE	W	350	.0013441	.0002558
890	KINNEAR	W	50	.0013441	.0002558
313	BIRNEY	M	20	.0013441	.0021529
931	PARKMAN	W	25	.0013441	.0010764
344	JOLIET	M	412	.0013212	.0025951
572	WALL	S	786	.0012420	.0064331
153	WELLINGTON	C	691	.0012450	.0012974
15	BRECKENRDG	C	548	.0012182	.0116359
627	KAMAS	U	806	.0011921	.0040874
644	PARK CITY	U	1193	.0011470	.0127324
95	LAPORTE	C	800	.0010974	.0007925
35	EAGLE	C	790	.0010017	.0088468
429	LYMAN	N	561	.0010017	.0146814
61	GRAND LAKE	C	189	.0009463	.0132509
899	LINGLE	W	446	.0009044	.0051997
112	NEW CASTLE	C	499	.0008413	.0084846
933	PINE BLUFF	W	937	.0007937	.0183884
126	PINE	C	35	.0008229	.0021902
81	IDLEDALE	C	350	.0007782	.0000000
618	GOSHEN	U	459	.0007229	.0015881
218	FIRTH	I	362	.0007229	.0008176
70	HAYDEN	C	763	.0007568	.0049129
385	WILSALL	M	200	.0007437	.0007925
92	KITTREDGE	C	50	.0007306	.0024309
10	BENNETT	C	613	.0006806	.0017771
119	OVID	C	463	.0006752	.0005367
813	BIG HORN	W	200	.0006883	.0013003
22	CENTRALCTY	C	228	.0007067	.0056099
50	FRISCO	C	471	.0006461	.0113548
118	OTIS	C	521	.0006121	.0021499
29	DACONO	C	360	.0006461	.0016102
844	DUBOIS	W	898	.0006645	.0089558
957	SHOSHONI	W	562	.0005775	.0040451
233	MENAN	I	545	.0005907	.0002558
916	MILLS	W	1724	.0005698	.0002239
255	SUGAR CITY	I	617	.0005830	.0027467
237	NEWDALE	I	267	.0005907	.0002558
640	NEWTON	U	444	.0005772	.0002558
635	MILLVILLE	U	441	.0005907	.0000000
372	SHEPHERD	M	100	.0005353	.0010764
612	DUCHESNE	U	1094	.0005353	.0083096

261	UCON	I	664	.0005407	.0000000
144	STRASBURG	C	600	.0005353	.0115380
336	GARDINER	M	650	.0005222	.0041482
614	EDEN	U	200	.0005353	.0000000
846	EDGERTON	W	350	.0005218	.0067390
248	ROBERTS	I	393	.0005353	.0056375
335	GALLATIN G	M	200	.0005276	.0024879
73	HILLROSE	C	121	.0005222	.0015216
44	FLEMING	C	349	.0004722	.0010165
107	MERINO	C	260	.0004853	.0000000
383	W YELLWSTN	M	756	.0004799	.0174377
342	HUNTLEY	M	250	.0004853	.0015812
240	PARIS	I	615	.0004799	.0028790
527	HILL CITY	S	389	.0004168	.0035396
648	RANDOLPH	U	500	.0004299	.0008176
231	LORENZO	I	100	.0004431	.0000000
259	TETON	I	390	.0004168	.0018690
369	ROBERTS	M	300	.0004168	.0026645
160	YAMPA	C	286	.0004168	.0016131
835	COWLEY	W	366	.0004245	.0013322
507	BUFFALO	S	393	.0004245	.0044647
958	SINCLAIR	W	445	.0004168	.0010484
443	WHITECLAY	N	90	.0004245	.0048173
428	LODGEPOLE	N	407	.0004168	.0026045
634	MIDWAY	U	804	.0004299	.0029705
28	CROOK	C	199	.0004168	.0015532
413	DALTON	N	354	.0003507	.0018371
977	WILSON	W	200	.0003507	.0029396
236	MORELAND	I	300	.0003691	.0002558
506	BOX ELDER	S	607	.0003614	.0007925
375	SILVERGATE	M	20	.0003691	.0008176
257	SWAN VALLY	I	235	.0003614	.0002809
154	WIGGINS	C	400	.0003746	.0023138
381	VIRGINIA C	M	149	.0003691	.0031094
202	ARIMO	I	252	.0003746	.0005367
913	MEETEETSE	W	459	.0003691	.0040692
219	FRANKLIN	I	402	.0003691	.0018025
306	BALLANTINE	M	350	.0003192	.0002558
360	PARK CITY	M	300	.0003192	.0013573
152	WELDON	C	150	.0003060	.0000000
855	FT WASHKIE	W	300	.0003323	.0026645
108	MILLIKEN	C	702	.0003060	.0051845
362	PONY	M	150	.0003192	.0013003
420	HARRISON	N	377	.0003192	.0029203
660	WHITEROCKS	U	300	.0003060	.0010764
656	TRENTON	U	390	.0003192	.0013003
12	BLACKHAWK	C	217	.0003060	.0018940
37	ECKLEY	C	193	.0003060	.0010764
226	IONA	I	890	.0003192	.0010764
137	SILT	C	434	.0003192	.0049119

16	BRIGGSDALE	C	75	.0003060	.0000000
823	BURNS	W	185	.0002638	.0004797
303	ALDER	M	100	.0002638	.0018690
915	MIDWEST	W	825	.0002769	.0007925
810	BANNER	W	40	.0002638	.0000000
114	NIWOT	C	200	.0002638	.0002558
384	WILLOW CRK	M	150	.0002638	.0010764
872	HANNA	W	460	.0002400	.0020620
262	VICTOR	I	241	.0002769	.0034502
54	GILL	C	140	.0002638	.0002558
409	BUSHNELL	N	211	.0002638	.0010165
376	SILVERSTAR	M	75	.0002638	.0002809
206	BASALT	I	349	.0002084	.0000000
550	PIEDMONT	S	200	.0002084	.0002558
205	BANCROFT	I	366	.0002215	.0043279
408	BROADWATER	N	141	.0002084	.0018371
609	CLARKSTON	U	420	.0002084	.0000000
828	CENTENNIAL	W	100	.0002084	.0005618
601	ALTAMONT	U	129	.0002084	.0002239
49	FREDERICK	C	696	.0002084	.0014894
109	MINTURN	C	706	.0002084	.0029105
90	KERSEY	C	474	.0002215	.0015532
541	NEMO	S	65	.0002084	.0002809
638	MYTON	U	322	.0002084	.0002239
232	MCCAMMON	I	623	.0002084	.0007925
604	BLUEBELL	U	30	.0001530	.0010764
961	STORY	W	400	.0001661	.0010415
629	LAPOINT	U	200	.0001530	.0010764
964	TENSLEEP	W	320	.0001661	.0047130
247	RIRIE	I	575	.0001661	.0026547
123	PEETZ	C	186	.0001530	.0000000
365	PRYOR	M	50	.0001530	.0010764
836	CROWHEART	W	10	.0001530	.0010764
632	MANILA	U	226	.0001661	.0013322
140	SNYDER	C	150	.0001530	.0000000
894	LANCECREEK	W	175	.0001530	.0002558
80	IDALIA	C	85	.0001530	.0013293
430	MCGREW	N	79	.0001530	.0010764
932	PAVILLION	W	181	.0001661	.0002558
350	MCALLISTER	M	10	.0001661	.0000000
438	POTTER	N	356	.0001661	.0024691
839	DEAVER	W	112	.0001530	.0005367
546	OGLALA	S	50	.0001530	.0010764
242	PINGREE	I	100	.0001530	.0010764
969	UPTON	W	987	.0001661	.0078525
628	LAKETOWN	U	208	.0001530	.0005116
77	HUDSON	C	518	.0001530	.0015532
419	HARRISBURG	N	100	.0001661	.0002809
318	BROADVIEW	M	123	.0001108	.0007356
544	NISLAND	S	157	.0001108	.0005116

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905   LYMAN        W    643   .0001108   .0020359
  5   ATWOOD       C    100   .0001108   .0005116
826   CARPENTER    W    100   .0001108   .0000000
213   DAYTON       I    198   .0001108   .0002558
912   MEDICINE B   W    455   .0001108   .0054871
 43   FIRESTONE    C    570   .0001108   .0002809
910   MANDERSON    W    117   .0001108   .0013573
837   DANIEL       W    125   .0001108   .0015562
418   GURLEY       N    233   .0001108   .0007356
345   LAME DEER    M    300   .0001108   .0031097
234   MONTEVIEW    I     10   .0001108   .0010764
880   HULETT       W    318   .0001108   .0015881
882   HYATTVILLE   W    100   .0001108   .0002809
938   RANCHESTER   W    208   .0001108   .0010165
 84   JAMESTOWN    C    185   .0000554   .0000000
217   FELT         I     35   .0000000   .0000000
  7   AVON         C     35   .0000000   .0010764
158   WOODROW      C     20   .0000000   .0027147
132   REDFEATHER   C     50   .0000000   .0018940
 53   GILCREST     C    382   .0000554   .0057196
241   PARKER       I    266   .0000554   .0000000
563   ROCHFORD     S     90   .0000000   .0000000
310   BIDDLE       M     25   .0000000   .0000000
432   MELBETA      N    124   .0000000   .0005367
 71   HEREFORD     C     75   .0000554   .0002809
138   SILVERPLUM   C    164   .0000000   .0002558
414   DIX          N    342   .0000000   .0030059
508   BUFFALOGAP   S    155   .0000000   .0000000
371   ST XAVIER    M    100   .0000554   .0010764
526   HERMOSA      S    150   .0000000   .0005618
 85   JOES         C    110   .0000000   .0008176
 38   EDWARDS      C     10   .0000000   .0002558
554   PRAIRIE CT   S     50   .0000554   .0018690
227   IRWIN        I    228   .0000554   .0000000
 13   BOND         C     80   .0000000   .0002558
571   VALE         S    115   .0000554   .0000000
 82   ILIFF        C    193   .0000000   .0016953
 62   GRANDVALLY   C    270   .0000000   .0024057
 26   COWDREY      C     60   .0000000   .0016131
212   CONDOR       I    200   .0000000   .0010764
105   MEAD         C    195   .0000000   .0002558
253   SQUIRREL     I      5   .0000554   .0010764
  4   ANTON        C     50   .0000000   .0010165
607   CACHE JNCT   U    100   .0000000   .0000000
228   ISLANDPARK   I    136   .0000000   .0031382
151   WARD         C     32   .0000000   .0016382
573   WASTA        S    127   .0000000   .0002558
564   ST ONGE      S     80   .0000554   .0000000
134   ROGGEN       C     50   .0000000   .0000000
 48   FRASER       C    221   .0000554   .0037630
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545	OELRICHS	S	94	.0000000	.0002558
617	GARDEN CTY	U	134	.0000000	.0008176
626	JENSEN	U	300	.0000000	.0005116
121	PAOLI	C	52	.0000000	.0002558
122	PARSHALL	C	100	.0000554	.0003193
510	CAPUTA	S	40	.0000000	.0010764
124	PHIPPSBURG	C	150	.0000000	.0024338
566	SMITHWICK	S	40	.0000000	.0000000
117	ORCHARD	C	75	.0000000	.0005116
343	JEFFERS	M	60	.0000000	.0000000
368	REED POINT	M	100	.0000000	.0013322
51	GALETON	C	170	.0000554	.0002558
568	ORAL	S	60	.0000000	.0010764
637	MT HOME	U	50	.0000000	.0010764
211	CLIFTON	I	137	.0000000	.0010764
427	LISCO	N	150	.0000554	.0007925
366	RAPELJE	M	100	.0000554	.0010764
532	KYLE	S	70	.0000554	.0000000
3	AMHERST	C	100	.0000000	.0002558
643	PARADISE	U	399	.0000554	.0015881
535	LODGEPOLE	S	20	.0000000	.0010764
258	TERRETON	I	50	.0000000	.0013322
102	MCCOY	C	25	.0000000	.0000000
104	MAYBELL	C	145	.0000000	.0002809
68	HAMILTON	C	15	.0000000	.0010764
615	ELBERTA	U	50	.0000554	.0010764
616	FT DUCHSNE	U	200	.0000000	.0030276
387	WYOLA	M	100	.0000000	.0005367
442	SUNOL	N	100	.0000000	.0000000
653	TABIONA	U	125	.0000554	.0010764
305	ASHLAND	M	150	.0000554	.0056134
113	NEW RAYMER	C	68	.0000000	.0002558
55	GILMAN	C	350	.0000554	.0045455
78	HYGIENE	C	250	.0000000	.0005367
156	WINTERPARK	C	50	.0000000	.0011236
157	WOLCOTT	C	35	.0000000	.0010764
661	WOODRUFF	U	173	.0000554	.0013003
801	ACME	W	100	.0000000	.0010764
415	ELLSWORTH	N	15	.0000000	.0000000
803	ALBIN	W	118	.0000554	.0000000
804	ALCOVA	W	80	.0000554	.0013322
808	BAGGS	W	146	.0000554	.0005367
264	WESTON	I	230	.0000554	.0000000
129	RAND	C	15	.0000000	.0002558
812	BEULAH	W	65	.0000000	.0002809
423	HENRY	N	147	.0000000	.0004797
210	CHESTER	I	100	.0000000	.0013573
817	BONDURANT	W	100	.0000000	.0000000
576	WOUNDED KN	S	50	.0000000	.0010764
96	LINDON	C	40	.0000000	.0000000

136	SEVERANCE	C	59	.0000000	.0002558
824	BURRIS	W	10	.0000000	.0002809
825	BYRON	W	397	.0000554	.0016131
100	LUCERNE	C	75	.0000000	.0005367
539	MEADOW	S	25	.0000000	.0000000
221	GEORGETOWN	I	421	.0000554	.0013322
613	ECHO	U	60	.0000000	.0010415
830	CHUGWATER	W	187	.0000000	.0005367
831	CLEARMONT	W	141	.0000000	.0002558
30	DEER TRAIL	C	374	.0000000	.0023206
833	COKEVILLE	W	440	.0000554	.0029203
834	CORA	W	5	.0000000	.0010764
33	DINOSAUR	C	247	.0000554	.0015851
444	WHITNEY	N	82	.0000554	.0002558
621	HENEFER	U	446	.0000000	.0021529
639	NEOLA	U	400	.0000554	.0010764
553	PORCUPINE	S	25	.0000000	.0010764
840	DEVILS TOW	W	10	.0000000	.0016131
841	DIAMONDVIL	W	485	.0000554	.0018381
842	DIXON	W	72	.0000000	.0000000
238	OVID	I	145	.0000554	.0000000
509	CAMP CROOK	S	150	.0000000	.0016131
845	DWYER	W	20	.0000554	.0002809
512	CENTRL CTY	S	188	.0000554	.0005618
847	ELK MOUNT	W	127	.0000000	.0010764
849	ENCAMPMENT	W	321	.0000000	.0020834
204	ATOMIC CTY	I	24	.0000000	.0002558
853	FT BRIDGER	W	150	.0000554	.0013003
519	ENNING	S	15	.0000000	.0000000
131	REDCLIFF	C	621	.0000000	.0018690
856	FRANNIE	W	139	.0000000	.0000000
250	ST CHARLES	I	200	.0000000	.0005367
819	BOULDER	W	75	.0000000	.0010764
56	GLEN HAVEN	C	25	.0000000	.0021749
864	GRANGER	W	137	.0000000	.0000000
59	GOULD	C	40	.0000000	.0018371
256	SWAN LAKE	I	135	.0000000	.0010764
869	GUERNSEY	W	793	.0000554	.0064565
870	GRASSCREEK	W	115	.0000000	.0000000
540	MUD BUTTE	S	10	.0000000	.0000000
260	TETONIA	I	176	.0000000	.0018120
875	HAWK SPGS	W	100	.0000554	.0002809
876	HILAND	W	10	.0000000	.0000000
877	HILLSDALE	W	80	.0000000	.0000000
879	HUDSON	W	381	.0000000	.0007857
304	ALZADA	M	50	.0000000	.0007925
881	HUNTLEY	W	80	.0000000	.0000000
501	ARDMORE	S	14	.0000000	.0000000
862	GLENDO	W	210	.0000554	.0021499
658	WALLSBURG	U	211	.0000554	.0010764

886	KAYCEE	W	272	.0000554	.0020997
887	KEELINE	W	30	.0000000	.0002558
888	KELLY	W	25	.0000554	.0013573
561	REDOWL	S	10	.0000000	.0000000
562	REVA	S	5	.0000000	.0010764
891	LA BARGE	W	500	.0000554	.0024057
892	LAGRANGE	W	189	.0000554	.0002558
893	LAMONT	W	100	.0000000	.0002558
319	BUSBY	M	300	.0000000	.0010764
320	CAMERON	M	10	.0000554	.0013573
570	UNION CNTR	S	35	.0000000	.0000000
323	COOKE CITY	M	30	.0000000	.0032012
900	LITTL AMER	W	60	.0000000	.0005367
326	CUSTER	M	350	.0000554	.0024308
327	DECKER	M	5	.0000554	.0010764
328	EDGAR	M	130	.0000554	.0000000
906	LYSITE	W	50	.0000000	.0010764
330	EMIGRANT	M	25	.0000000	.0002809
606	BRIDGELAND	U	20	.0000000	.0010764
333	FISHTAIL	M	80	.0000554	.0013573
334	FROMBERG	M	364	.0000554	.0005367
25	COPE	C	110	.0000000	.0005367
917	MONETA	W	10	.0000000	.0016382
918	MOORCROFT	W	981	.0000554	.0041193
919	MOOSE	W	50	.0000000	.0002558
920	MORAN	W	10	.0000000	.0007925
921	MORTON	W	5	.0000000	.0002809
922	MOUNT VIEW	W	500	.0000554	.0015562
923	NATRONA	W	5	.0000000	.0010764
619	HANNA	U	25	.0000000	.0013573
927	OPAL	W	34	.0000000	.0010764
348	LODGEGRASS	M	806	.0000554	.0036741
885	JAY EM	W	15	.0000000	.0010764
354	MELVILLE	M	15	.0000000	.0010764
356	MOLT	M	20	.0000000	.0010764
357	NORRIS	M	25	.0000554	.0013322
935	POWDER RVR	W	50	.0000000	.0013573
361	POMPEYS PL	M	100	.0000000	.0010764
937	RALSTON	W	100	.0000554	.0002558
364	PRAY	M	0	.0000000	.0005618
125	PIERCE	C	452	.0000000	.0002239
940	RECLUSE	W	10	.0000554	.0000000
516	DENBY	S	10	.0000000	.0010764
944	ROCK RIVER	W	344	.0000000	.0007925
854	FT LARAMIE	W	197	.0000000	.0005116
370	ROSCOE	M	50	.0000000	.0010764
952	SAVERY	W	25	.0000000	.0010764
954	SHAWNEE	W	25	.0000000	.0010764
955	SHELL	W	50	.0000000	.0005367
531	KEYSTONE	S	500	.0000554	.0016033

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 641    OAKLEY       U        265      .0000000      .0016131
 377    SPRINGDALE   M         50      .0000000      .0010764
 960    SMOOT        W        100      .0000000      .0002558
 379    TRIDENT      M        100      .0000000      .0010764
 645    PEOA         U        130      .0000000      .0010764
 871    HAMILTON DMW          100      .0000554      .0000000
 965    THAYNE       W        195      .0000554      .0016131
 145    TABERNASH    C        250      .0000000      .0005367
 146    TIMNATH      C        177      .0000554      .0027467
 147    TOPONAS      C         70      .0000000      .0010764
 972    WALCOTT      W         20      .0000000      .0002558
 973    WAMSUTTER    W        139      .0000000      .0021499
 974    WAPITI       W         25      .0000000      .0002809
 655    THISTLE      U         50      .0000000      .0002558
  75    H SULPHUR   SC        220      .0000554      .0050227
 552    PLAINVIEW    S          5      .0000000      .0000000
 982    YODER        W        101      .0000554      .0002809
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APPENDIX "E"

LIST OF HEALTH MANPOWER EDUCATION PROGRAMS AND CHARACTERISTICS

This appendix is a list of the health manpower education programs in the region. The listing is ordered according to the type of program. Program characteristics include date of first enrollment (origin), length of program, award, clinical training, 1970 full-time enrollment, graduates for 1969-70 and 1970-71, and enrollment capacity.

Health Program	City	Origin	Length (months)	Award	Clinical training	Fulltime enrollment	Graduates 69-70	Graduates 70-71	Capacity
Biomedical Engineer	Laramie, WY	63	45	Bach.	yes	15	6	0	12
	Laramie, WY	64	23	Mast.	yes	11	2	3	7
	Laramie, WY	64	6	Doct.	yes	1	1	1	4
Child Health Associate	Denver, CO	69	36	Bach.	yes	23	0	0	15
Dental Assistant	Rangely, CO	69	9	Cert.	yes	5	0	5	30
	Rangely, CO	69	21	Assoc	yes	18	0	1	30
	Provo, UT	61	9	Cert.	yes	39	20	35	40
	Denver, CO	68	24	Assoc	yes	41	3	10	25
Dental Hygienist	Pocatello, ID	61	18	Bach.	yes	39	20	12	22
	Rangely, CO	62	21	Assoc	yes	47	20	19	25
	Sheridan, WY	69	20	Assoc	yes	35	0	13	20
Dental Lab Technician	Sheridan, WY	69	2	Assoc	yes	3	0	1	2
Dietician/Nutritionist	Fort Collins, CO	37	48	Bach.	yes	90	31	16	276
	Fort Collins, CO	37	18	Mast.	yes	18	5	11	50
	Fort Collins, CO	64	36	Doct.	yes	2	0	2	4
	Bozeman, MT	18	48	Bach.	yes	20	4	10	15
	Bozeman, MT	68	12	Mast.	yes	2	2	2	5
	Provo, UT	45	45	Bach.	yes	78	15	14	30
	Salt Lake City, UT	30	46	Bach.	yes	38	11	9	24
	Salt Lake City, UT	30	14	Mast.	yes	1	0	1	8
	Logan, UT	42	33	Bach.	yes	30	6	6	35
	Laramie, WY	49	45	Bach.	yes	20	0	5	20
Environmental Health Spec.	Fort Collins, CO	69	44	Bach.	yes	12	0	1	24
	Bozeman, MT	56	44	Bach.	yes	25	1	2	15
	Bozeman, MT	65	12	Mast.	yes	2	0	1	10
	Logan, UT	56	45	Bach.	yes	7	3	3	15
Environmental Technician	Cheyenne, WY	70	24	Assoc	yes	9	0	9	20
Health Educator	Greeley, CO	68	48	Bach.	yes	22	115	129	362
	Greeley, CO	56	27	Doct.	yes	3	1	0	8
	Greeley, CO	52	12	Mast.	yes	10	10	9	20
	Provo, UT	--	44	Bach.	yes	82	17	22	30
	Provo, UT	60	12	Mast.	yes	18	8	12	25
	Logan, UT	17	45	Bach.	yes	7	2	3	--
Health Administration Ass't.	Cheyenne, WY	70	9	Cert.	yes	5	0	5	10

Health Program	City	Origin	Length (months)	Award	Clinical training	Fulltime Enrollment	Graduates 69-70	Graduates 70-71	Capacity
Health Service Administrator	Denver, CO	67	21	Mast.	yes	[illegible]	0	11	.20
Inhalation Therapist	Ogden, UT	69	21	Assoc	yes	45	0	12	16
	Denver, CO	68	21	Assoc	yes	53	12	14	35
	Denver, CO	69	12	Cert.	yes	9	3	9	25
Lab Assistant	Cheyenne, WY	70	24	Assoc	yes	4	0	4	20
	Denver, CO	69	18	Assoc	yes	21	0	4	20
Licensed Practical Nurse	Sterling, CO	62	12	Cert.	yes	20	17	18	18
	Provo, UT	50	12	Cert.	yes	48	26	40	50
	Salt Lake City, UT	48	12	Cert.	yes	112	77	80	100
	Casper, WY	59	12	Cert.	yes	31	28	0	36
	Denver, CO	70	12	Cert.	yes	25	0	20	30
	Denver, CO	66	21	Assoc	yes	100	24	35	100
	Idaho Falls, ID	--	--	Cert.	no	13	0	5	--
	Billings, MT	69	12	Dip.	yes	37	0	29	37
	Bozeman, MT	65	12	Dip.	yes	[illegible]	28	17	23
	Alliance, NB	58	12	Dip.	yes	[illegible]	42	37	48
	Scottsbluff, NB	70	12	Dip.	yes	[illegible]	0	23	50
	Rapid City, SD	69	12	Dip.	yes	28	19	20	28
	Ogden, UT	43	12	Cert.	yes	30	23	26	35
	Provo, UT	--	20	Assoc	yes	110	54	53	100
	Laramie, WY	63	12	Dip.	yes	13	15	16	24
Medical Office Assistant	Denver, CO	67	18	Assoc	yes	19	3	6	12
Medical School	Salt Lake City, UT	1905	--	M.D.	yes	310	60	62	--
	Denver, CO	1883	--	M.D.	yes	474	100	109	--
Medical Technologist	Fort Collins, CO	52	48	Bach.	no	114	9	17	36
	Denver, CO	37	45	Bach.	yes	106	26	28	30
	Denver, CO	63	33	Mast.	yes	33	1	1	6
	Greeley, CO	55	45	Bach.	no	43	6	7	10
	Bozeman, MT	42	44	Bach.	no	119	15	17	30
	Bozeman, MT	58	21	Mast.	yes	3	0	3	6
	Bozeman, MT	68	36	Doct.	yes	1	0	0	5
	Billings, MT	--	48	Bach.	no	10	0	2	10
	Chadron, NB	60	44	Bach.	no	27	6	7	25
	Spearfish, SD	64	51	Bach.	no	16	2	4	--

Health Program	City	Origin	Length (months)	Award	Clinical training	Fulltime enrollment	Graduates 69-70	70-71	Capacity
Medical Technologist	Provo, UT	50	48	Bach.	no	198	30	35	70
	Salt Lake City, UT	37	45	Bach.	no	158	19	30	35
	Salt Lake City, UT	69	24	Mast.	yes	3	3	0	5
	Logan, UT	50	45	Bach.	no	49	14	11	24
	Ogden, UT	64	47	Bach.	no	58	5	8	20
	Laramie, WY	47	45	Bach.	no	54	12	12	20
Mental Health Assistant	Denver, CO	67	21	Assoc	yes	173	16	43	65
Nuclear Medicine Technician	Denver, CO	69	24	Cert.	yes	20	0	10	12
Occupational Therapist	Fort Collins, CO	46	54	Bach.	yes	298	35	45	60
	Fort Collins, CO	51	26	Cert.	yes	6	2	3	8
	Fort Collins, CO	70	12	Mast.	yes	1	0	1	6
Pharmacy	Boulder, CO	11	45	Bach.	no	170	35	36	170
	Salt Lake City, UT	46	45	Bach.	no	331	53	55	350
	Pocatello, ID	18	45	Bach.	no	185	46	36	200
	Laramie, WY	48	45	Bach.	no	173	22	26	—
Physical Therapist	Denver, CO	48	12	Bach.	yes	48	53	48	48
	Billings, MT	60	48	Bach.	no	1	0	0	10
	Chadron, NB	68	66	Bach.	no	9	2	3	20
	Salt Lake City, UT	69	21	Bach.	yes	40	0	22	24
Radiation Health Spec.	Fort Collins, CO	61	12	Mast.	yes	8	14	5	20
	Fort Collins, CO	61	36	Doct.	yes	19	6	3	5
Radiation Health Technician	Pocatello, ID	64	24	Cert.	yes	23	7	6	15
Radiological Technician	Salt Lake City, UT	52	24	Cert.	yes	1	11	6	24
	Ogden, UT	67	27	Assoc	no	25	5	8	16
	Cheyenne, WY	70	24	Assoc	yes	18	0	18	20
	Denver, CO	68	24	Cert.	yes	124	12	24	100
Radiation Therapy Technician	Denver, CO	69	24	Cert.	yes	12	0	6	10
Recreation Therapist	Provo, UT	70	45	Bach.	yes	14	0	20	20
	Provo, UT	70	9	Mast.	yes	1	0	7	20
Registered Nurse	Rexburg, ID	57	19	Assoc	yes	76	31	0	50
	Casper, WY	69	20	Assoc	yes	60	0	22	30
	Denver, CO	69	18	Assoc	yes	93	0	30	100
	Denver, CO	69	24	Assoc	yes	119	0	55	90
	Greeley, CO	63	39	Bach.	yes	500	27	54	500
	Denver, CO	--	60	Bach.	yes	320	146	2	320

Health Program	City	Origin	Length (months)	Award	Clinical training	Fulltime enrollment	Graduates 69-70	Graduates 70-71	Capacity
Registered Nurse	Denver, CO	47	36	Bach.	yes	222	43	41	250
	Denver, CO	26	27	Bach.	yes	163	35	35	190
	Pocatello, ID	52	36	Bach.	yes	145	22	31	175
	Pocatello, ID	65	38	Cert.	yes	27	25	27	27
	Bozeman, MT	37	36	Bach.	yes	702	117	104	750
	Scottsbluff, NB	24	36	Dip.	yes	91	19	27	95
	Rapid City, SD	27	36	Dip.	yes	90	31	30	150
	Salt Lake City, UT	48	36	Bach.	yes	277	31	50	100
	Salt Lake City, UT	68	36	Bach.	yes	120	0	0	200
	Provo, UT	--	36	Bach.	yes	245	65	57	--
	Laramie, WY	53	36	Bach.	yes	220	37	23	220
Rehabilitation Counselor	Billings, MT	68	21	Mast.	yes	17	6	12	12
Speech Pathologist/Audiologist	Fort Collins, CO	62	15	Mast.	yes	28	15	13	20
	Denver, CO	52	45	Bach.	yes	65	0	13	20
	Denver, CO	68	48	Bach.	yes	7	0	5	15
	Greeley, CO	58	12	Mast.	yes	7	7	8	20
	Greeley, CO	70	24	Doct.	yes	1	0	0	2
	Boulder, CO	--	24	Mast.	yes	23	7	8	30
	Boulder, CO	64	36	Doct.	yes	8	0	4	20
	Denver, CO	43	18	Mast.	yes	93	68	75	75
	Pocatello, ID	--	11	Mast.	yes	10	3	0	10
	Pocatello, ID	52	45	Bach.	yes	64	10	10	35
	Salt Lake City, UT	47	12	Mast.	yes	24	15	20	25
	Salt Lake City, UT	47	45	Bach.	yes	72	19	17	25
	Salt Lake City, UT	47	36	Doct.	yes	7	3	1	10
	Logan, UT	46	12	Mast.	yes	21	5	12	20
	Logan, UT	46	21	Bach.	yes	40	15	15	25
	Laramie, WY	47	12	Mast.	yes	8	5	4	15
	Laramie, Wy	47	48	Bach.	yes	72	10	12	150
Surgical Technician	Cheyenne, WY	69	12	Cert.	yes	4	0	4	20
	Denver, CO	70	9	Cert.	yes	19	0	19	25

APPENDIX "F"

GEOGRAPHIC DISTRIBUTION OF GRADUATES FROM HEALTH MANPOWER EDUCATION PROGRAMS

Included in this appendix is a listing of selected health manpower education programs and the distribution of graduates. Location of programs is identified by city instead of institution. The list of programs is not exhaustive. Only the programs in institutions giving a positive response are included. The bases for the data ranged from subjective estimation to time series data. A short statement about the bases is included.

PROGRAM

Licensed Practical Nurse

Denver: 95% remain in CO
5% go out of state
(Estimation by respondent)

Salt Lake City: 90% remain in Salt Lake City area
(Estimation by respondent)

Cheyenne: 77% remain in Cheyenne
9% go to WY cities other than Cheyenne

Casper: 61% remain in Casper
16% go to WY cities other than Casper
(Based on graduate data for one year)

Surgical Technician

Cheyenne: 75% remain in state
(Based on graduate data for one year)

X-ray Technician

Cheyenne: 75% remain in Cheyenne
25% go to other WY cities
(Based on graduate data for one year)

Environmental Health Technician

Cheyenne: 30% remain in Cheyenne
20% go to other WY cities
(Based on graduate data for one year)

Dental Hygienist

Pocatello:

Number of Students originating from		Percent of Students Returning to State of Original Residence
Nevada	9	56%
Montana	9	44%
Alaska	1	0
Canada	1	0
Colorado	2	0
New Mexico	1	0
Idaho	60	53%
California	17	82%
Utah	7	43%
Washington	10	60%
	117	

(Based on graduate data for ten years)

Dental Hygienist (cont.)

Sheridan: 42% remain in WY
(4 in Sheridan, 2 in Casper, 5 in Billings)
(Based on graduate data for two years)

Physical Therapists

Salt Lake City: 25% remain in Salt Lake City
21% go to other cities in UT
(Based on graduate data for two years)

Denver: 48% remain in CO
(Based on graduate data for 10 years)

Dietician

Laramie: 8% remain in WY
(only one in Laramie and she is unemployed)

Salt Lake City: 20% remain in UT
(Based on graduate data for 10 years)

Fort Collins: 28% remain in CO
(8 are located in Fort Collins; 6 of those 8 are employed in education)
(Based on graduate data for 10 years)

Medical Technologist

Denver: 60-75% remain in CO
(Estimation by respondent)

Registered Nurse

Laramie: Number of graduates whose first job was in:

Cheyenne	62
Casper	46
Laramie	43
Sheridan	26
Powell	8
Cody	8
Rock Springs	6
Thermopolis	6
Newcastle	4
Riverton	5
Gillette	3
Rawlins	2
Douglas	2
Evanston	1

Registered Nurse (cont.)

Laramie: Number of graduates whose first job was in:

Wheatland	1
Worland	1
Torrington	1
Jackson	1
Lander	1
Lovell	1
Kemmerer	1

(Based on graduate data for 10 year period)

Pharmacy

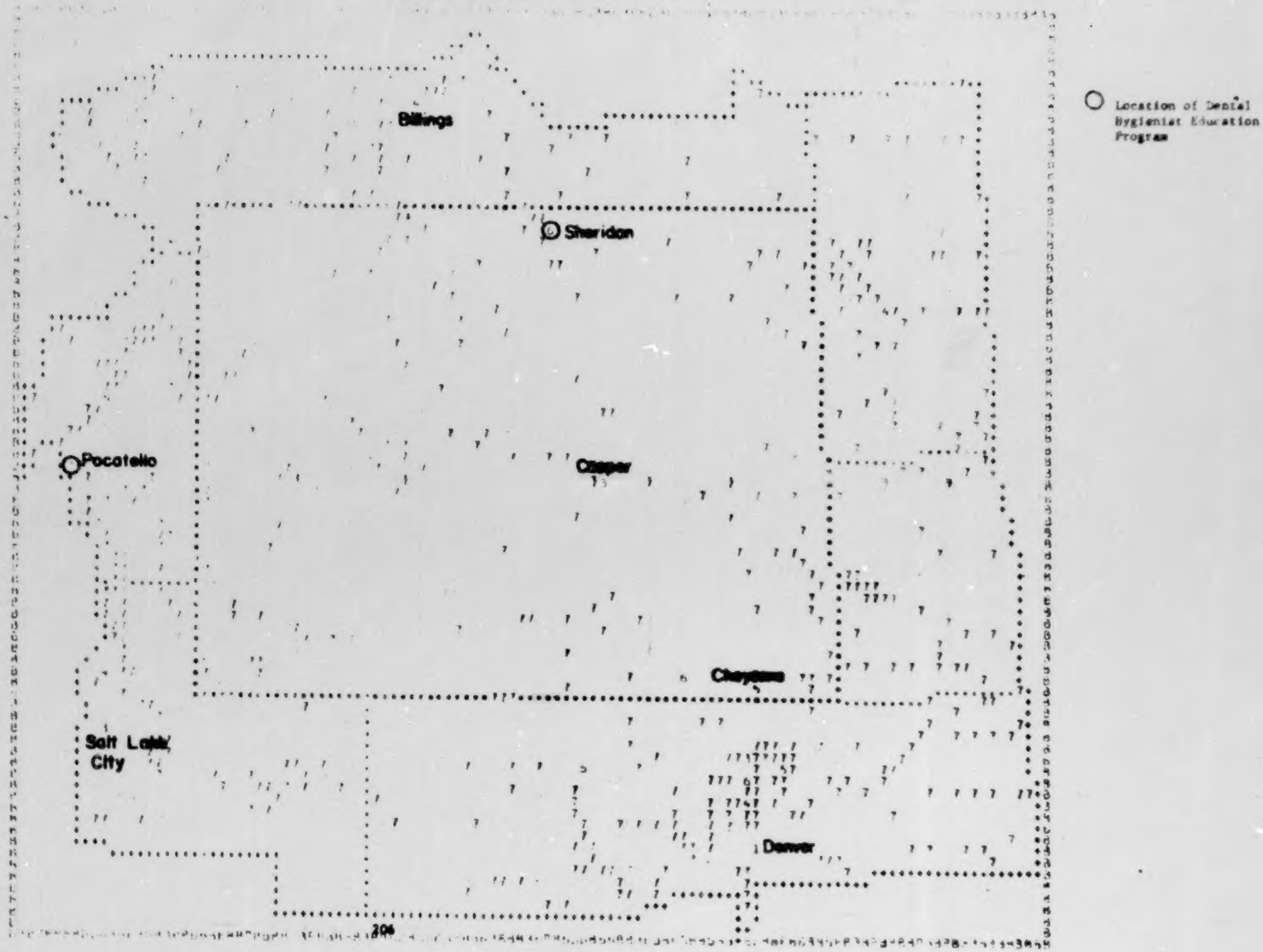
Laramie: 36% remain in WY
(Based on graduate data for 10 years)

APPENDIX "G"

HIERARCHIES BASED ON SELECTED HEALTH MANPOWER

Hierarchies were developed from the location and concentration of (1) dental hygienists, (2) physical therapists, (3) licensed practical nurses, and (4) registered nurses. The hierarchies are included in this appendix. Following each hierarchy is a map of the region based on the particular type of manpower. Communities having a health manpower education program of the type of manpower that the map is based on are circled.

MAP BASED ON DENTAL HYGIENIST HIERARCHY


Billings
Sheridan
Pocatello
Casper
Cheyenne
Salt Lake City
Denver
206
○ Location of Dental Hygienist Education Program

HIERARCHY BASED ON DENTAL HYGIENISTS

545 CITIES WERE FORMED INTO 7 GROUPS BASED ON
THE CENTRALITY INDEX FROM 1 SELECTED VARIABLES

GROUP 1	ID	CITY		POP	PROPORTION
	31	DENVER	C	999999	.6078838

GROUP 2	ID	CITY		POP	PROPORTION
	14	BOULDER	C	69279	.0414938
	243	POCATELLO	I	40036	.0352697

GROUP 3	ID	CITY		POP	PROPORTION
	651	SALT LAKE C	U	557635	.0290456
	45	FT. COLLINS	C	43337	.0290456

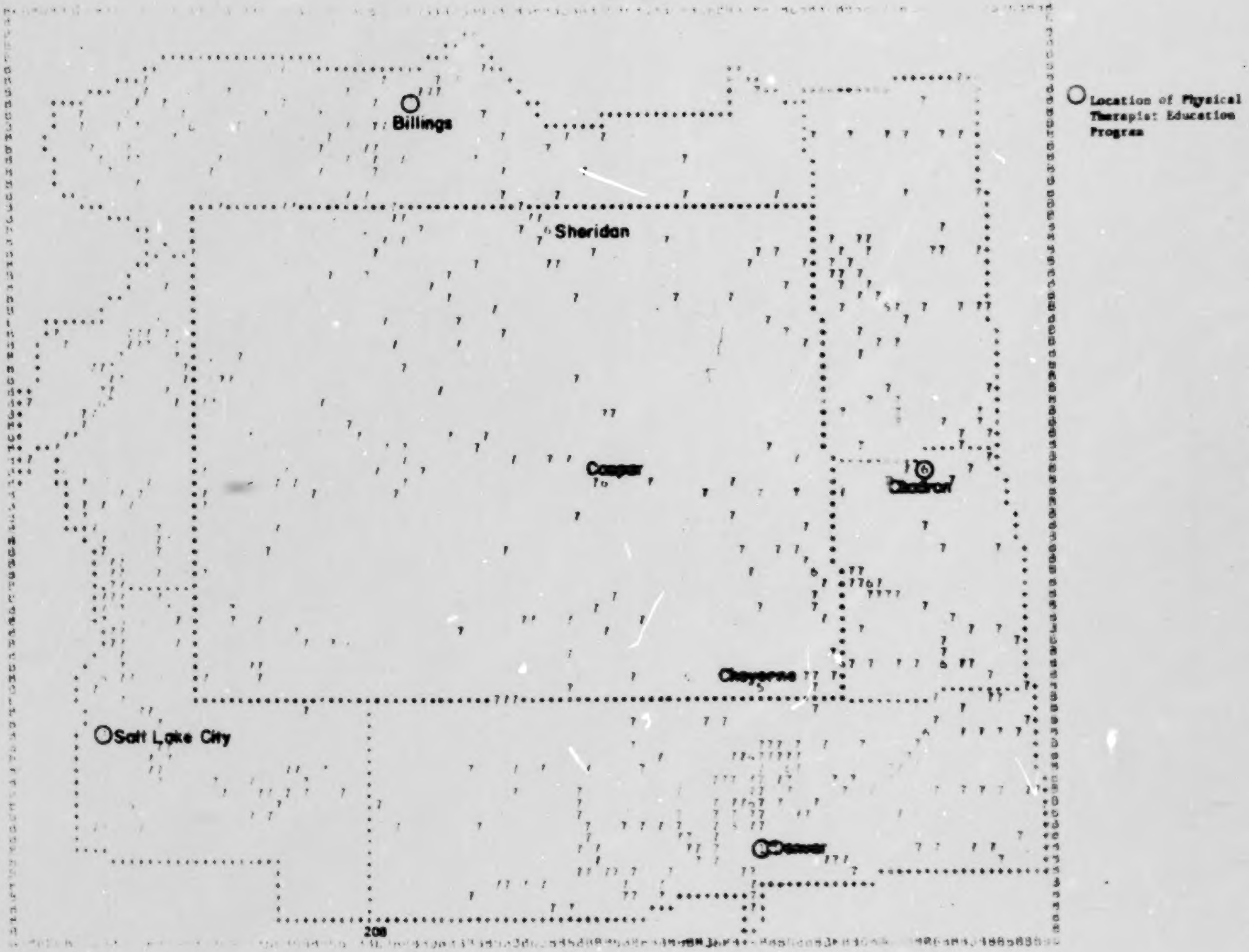
GROUP 4	ID	CITY		POP	PROPORTION
	98	LONGMONT	C	23209	.0207469
	559	RAPID CITY	S	43836	.0207469
	312	BILLINGS	M	61581	.0186722
	642	OGDEN	U	116945	.0165975

GROUP 5	ID	CITY		POP	PROPORTION
	63	GREELEY	C	40129	.0145228
	827	CASPER	W	39400	.0145228
	829	CHEYENNE	W	40000	.0124481
	224	IDAHO FALLS	I	35776	.0124481
	647	PROVO	U	119451	.0124481

GROUP 6	ID	CITY		POP	PROPORTION
	141	STEAMBOAT S	C	2340	.0082988
	956	SHERIDAN	W	10800	.0082988
	57	GLENWOOD SP	C	4106	.0082988
	79	IDAHO SPGS	C	2003	.0062241
	99	LOVELAND	C	16220	.0062241
	896	LARAMIE	W	24700	.0062241

GROUP 7	ID	CITY		POP	PROPORTION

MAP BASED ON PHYSICAL THERAPISTS HIERARCHY


Billings
Sheridan
Casper
Chadron
Cheyenne
Salt Lake City
Denver
208
○ Location of Physical Therapist Education Program

HIERARCHY BASED ON PHYSICAL THERAPISTS

545 CITIES WERE FORMED INTO 7 GROUPS BASED ON THE CENTRALITY INDEX FROM 1 SELECTED VARIABLES

GROUP 1	ID	CITY		POP	PROPORTION
	31	DENVER	C	999999	.5794979

GROUP 2	ID	CITY		POP	PROPORTION
	651	SALT LAKE C	U	557635	.1192468

GROUP 3	ID	CITY		POP	PROPORTION
	14	BOULDER	C	69279	.0460251

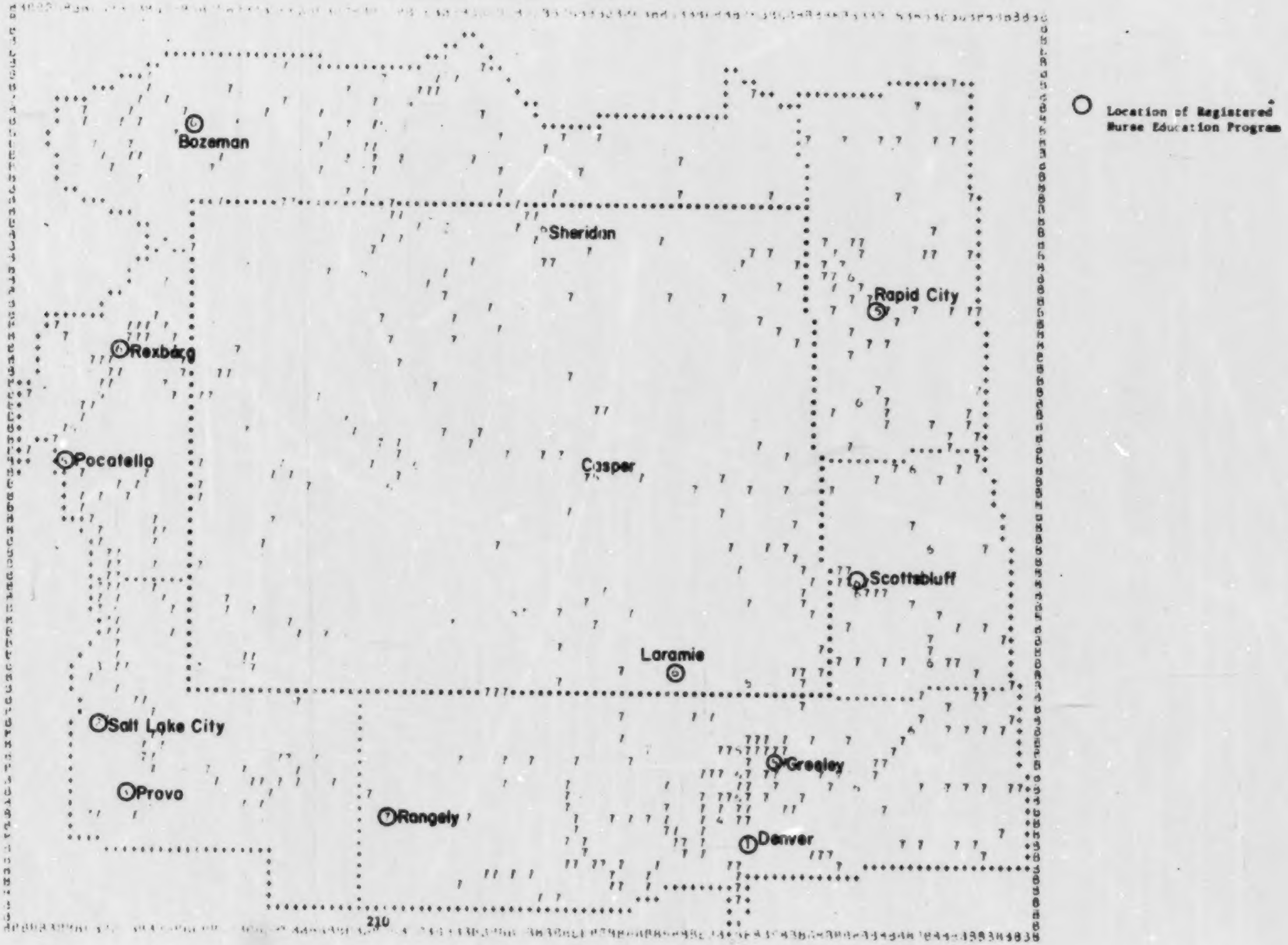
GROUP 4	ID	CITY		POP	PROPORTION
	45	FT. COLLINS	C	43337	.0292887
	647	PROVO	U	119451	.0271966

GROUP 5	ID	CITY		POP	PROPORTION
	642	OGDEN	U	116945	.0209205
	829	CHEYENNE	W	40000	.0167364
	559	RAPID CITY	S	43836	.0167364
	312	BILLINGS	M	61581	.0146444

GROUP 6	ID	CITY		POP	PROPORTION
	243	POCATELLO	I	40036	.0104603
	63	GREELEY	C	40129	.0083682
	315	BOZEMAN	M	18670	.0083682
	98	LONGMONT	C	23209	.0083682
	631	LOGAN	U	22333	.0062761
	896	LARAMIE	W	24700	.0062761
	440	SCOTTSBLUF	N	14507	.0041841
	827	CASPER	W	39400	.0041841
	410	CHADRON	N	5921	.0041841
	224	IDAHO FALLS	I	35776	.0041841
	142	STERLING	C	10636	.0041841
	945	ROCK SPGS	W	12100	.0041841
	968	TORRINGTON	W	4237	.0041841
	441	SIDNEY	N	6403	.0041841
	956	SHERIDAN	W	10800	.0041841

GROUP 7	ID	CITY		POP	PROPORTION

MAP BASED ON REGISTERED NURSES HIERARCHY


Location of Registered Nurse Education Program
Bozeman
Sheridan
Rapid City
Rexburg
Pocatello
Casper
Scottsbluff
Laramie
Salt Lake City
Greeley
Provo
Rangely
Denver
210

HIERARCHY BASED ON REGISTERED NURSES

545 CITIES WERE FORMED INTO 7 GROUPS BASED ON
THE CENTRALITY INDEX FROM 1 SELECTED VARIABLES

GROUP 1	ID	CITY		POP	PROPORTION
	31	DENVER	C	999999	.3965440

GROUP 2	ID	CITY		POP	PROPORTION
	651	SALT LAKE C	U	557635	.1401750

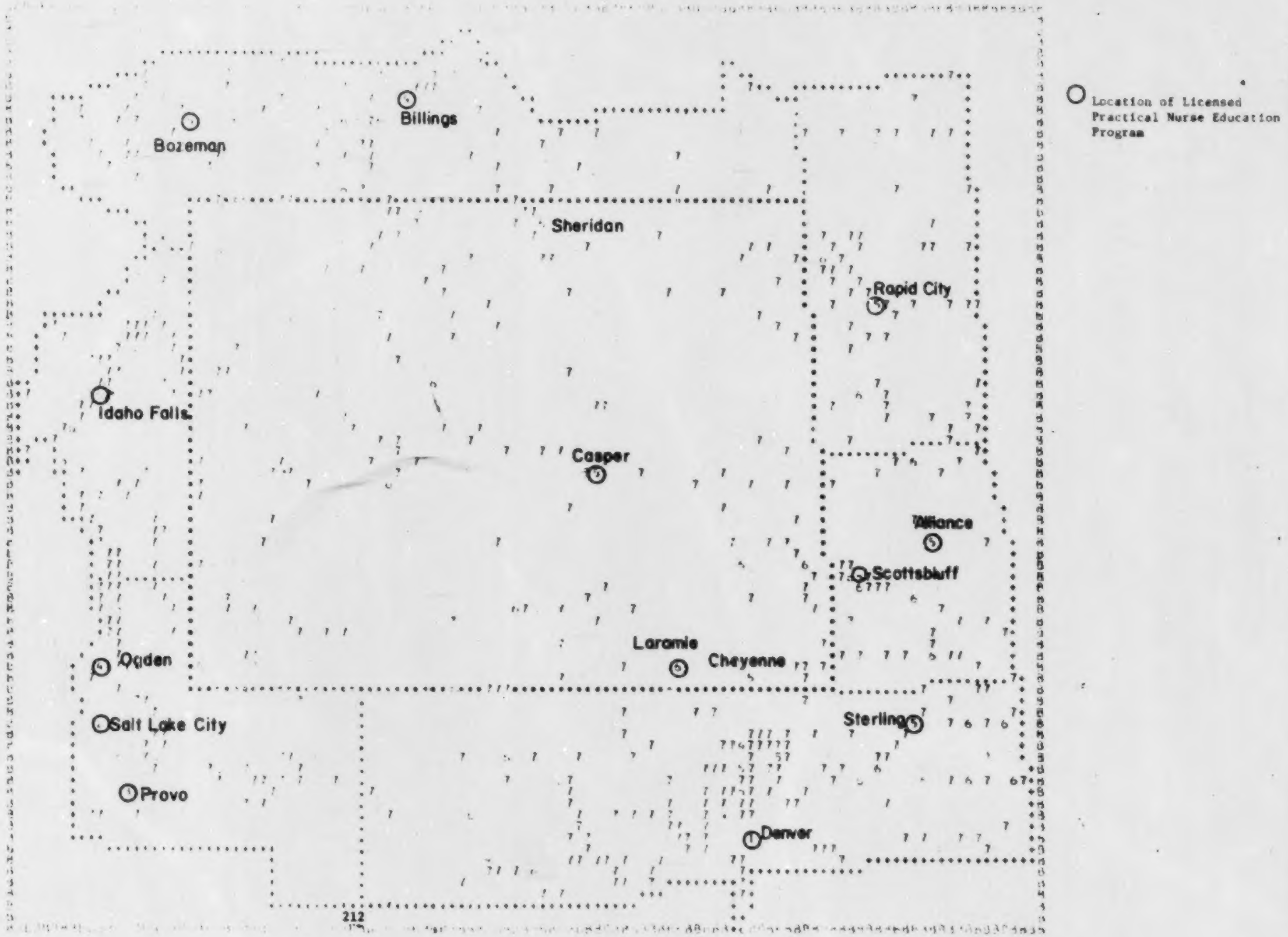
GROUP 3	ID	CITY		POP	PROPORTION
	642	OGDEN	U	116945	.0453589
	647	PROVO	U	119451	.0388790

GROUP 4	ID	CITY		POP	PROPORTION
	312	BILLINGS	M	61581	.0295193
	14	BOULDER	C	69279	.0291870

GROUP 5	ID	CITY		POP	PROPORTION
	63	GREELEY	C	40129	.0197718
	45	FT. COLLINS	C	43337	.0191072
	559	RAPID CITY	S	43836	.0190518
	829	CHEYENNE	W	40000	.0168919
	243	POCATELLO	I	40036	.0155073
	224	IDAHO FALLS	I	35776	.0152858
	827	CASPER	W	39400	.0140673

GROUP 6	ID	CITY		POP	PROPORTION
	98	LONGMONT	C	23209	.0115197
	315	BOZEMAN	M	18670	.0093598
	440	SCOTTSBLUF	N	14507	.0068121
	631	LOGAN	U	22333	.0064245
	896	LARAMIE	W	24700	.0064245
	956	SHERIDAN	W	10800	.0062029
	99	LOVELAND	W	16220	.0062029
	142	STERLING	C	10636	.0044307
	945	ROCK SPGS	W	12100	.0040430
	568	STURGIS	S	4536	.0036553
	208	BLACKFOOT	I	8716	.0034338
	416	GERING	N	5639	.0034338
	401	ALLIANCE	N	6862	.0033784
	347	LIVINGSTON	M	6883	.0030461
	441	SIDNEY	N	6403	.0026584
	832	CODY	W	5161	.0025476
	529	HOT SPRINGS	S	4434	.0024922
	895	LANDER	W	7125	.0023261
	939	RAWLINS	W	7855	.0022707
	245	REXBURG	I	8272	.0022707
	346	LAUREL	M	4454	.0021599
	942	RIVERTON	W	7995	.0021599
	46	FT. MORGAN	C	7594	.0021046
	410	CHADRON	N	5921	.0019938

MAP BASED ON LICENSED PRACTICAL NURSES HIERARCHY


Location of Licensed Practical Nurse Education Program
Bozeman
Billings
Sheridan
Rapid City
Idaho Falls
Casper
Alliance
Scottsbluff
Laramie
Cheyenne
Ogden
Salt Lake City
Sterling
Provo
Denver
212

HIERARCHY BASED ON LICENSED PRACTICAL NURSES

545 CITIES WERE FORMED INTO 7 GROUPS BASED ON
THE CENTRALITY INDEX FROM 1 SELECTED VARIABLES

GROUP 1	ID	CITY		POP	PROPORTION
	31	DENVER	C	999999	.3782708

GROUP 2	ID	CITY		POP	PROPORTION
	651	SALT LAKE C	U	557635	.1706197

GROUP 3	ID	CITY		POP	PROPORTION
	647	PROVO	U	119451	.0723795

GROUP 4	ID	CITY		POP	PROPORTION
	642	OGDEN	U	116945	.0368783
	45	FT. COLLINS	C	43337	.0266259
	14	BOULDER	C	69279	.0234124
	312	BILLINGS	M	61581	.0215761

GROUP 5	ID	CITY		POP	PROPORTION
	827	CASPER	W	39400	.0146901
	99	LOVELAND	C	16220	.0127008
	63	GREELEY	C	40129	.0122418
	98	LONGMONT	C	23209	.0116297
	559	RAPID CITY	S	43836	.0100995
	829	CHEYENNE	W	40000	.0094874
	142	STERLING	C	10636	.0091813
	243	POCATELLO	I	40036	.0088753
	401	ALLIANCE	N	6862	.0088753
	315	BOZEMAN	M	18670	.0082632
	440	SCOTTSBLUF	N	14507	.0076511

GROUP 6	ID	CITY		POP	PROPORTION
	896	LARAMIE	W	24700	.0058148
	224	IDAHO FALLS	I	35776	.0045907
	208	BLACKFOOT	I	8716	.0042846
	416	GERING	N	5639	.0042846
	46	FT. MORGAN	C	7594	.0038256
	956	SHERIDAN	W	10800	.0036725
	17	BRUSH	C	3377	.0036725
	441	SIDNEY	N	6403	.0035195
	434	MITCHELL	N	1842	.0032135
	347	LIVINGSTON	M	6883	.0032135
	529	HOT SPRINGS	S	4434	.0029074
	159	WRAY	C	1953	.0027544
	895	LANDER	W	7125	.0026014
	410	CHADRON	N	5921	.0026014
	631	LOGAN	U	22333	.0022953
	939	RAWLINS	W	7855	.0022953

161	YUMA	C	2259	.0021423
346	LAUREL	M	4454	.0021423
966	THERMOPOLIS	W	3063	.0019893
850	EVANSTON	W	4462	.0018363
620	HEBER	U	3245	.0018363
57	GLENWOOD SP	C	4106	.0018363
69	HAXTON	C	899	.0016832
1	AKRON	C	1775	.0016832
106	MEEKER	C	1597	.0016832
74	HOLYOKE	C	1640	.0015302
567	SPEARFISH	S	4661	.0015302
322	COLUMBUS	M	1173	.0015302
657	VERNAL	U	3908	.0013772
27	CRAIG	C	4205	.0013772
968	TORRINGTON	W	4237	.0013772
367	RED LODGE	M	1844	.0013772
976	WHEATLAND	W	2498	.0013772
407	BRIDGEPORT	N	1490	.0013772

GROUP 7	ID	CITY		POP	PROPORTION

APPENDIX "H"

RATIO OF LICENSED PRACTICAL NURSES TO REGISTERED NURSES

In this appendix the ratios of licensed practical nurses to registered nurses are ordered according to the magnitude of the economic index for the first six groups of communities.

ID	CITY		POP	ECON INDEX	HEALTH INDEX	LPNS	RNS	LPNS/RNS
31	DENVER	C	999999	5.0012417	9.3977852	2472	7160	.345
651	SALTLAKE C	U	557635	2.6214581	3.1379128	1115	2531	.441
312	BILLINGS	M	61581	.5846790	.5746168	141	533	.265
642	OGDEN	U	116945	.5777737	.7132918	241	819	.294
647	PROVO	U	119451	.5166960	.8387790	473	702	.674
827	CASPER	W	39400	.3894795	.3126797	96	254	.378
14	BOULDER	C	69279	.3869109	.5807378	153	527	.290
559	RAPID CITY	S	43836	.3489432	.5642818	66	344	.192
224	IDAHOFALLS	I	35776	.3119363	.3561957	30	276	.109
243	POCATELLO	I	40036	.2943655	.5227992	58	280	.207
45	FT COLLINS	C	43337	.2898801	.4798062	174	345	.504
63	GREELEY	C	40129	.2705990	.4265206	80	357	.224
829	CHEYENNE	W	40000	.2629849	.5523456	62	305	.203
98	LONGMONT	C	23209	.1833664	.2505936	76	208	.365
440	SCOTTSBLUF	N	14507	.1711982	.3160567	50	123	.407
315	BOZEMAN	M	18670	.1662389	.2360501	54	169	.320
631	LOGAN	U	22333	.1441042	.1942776	15	116	.129
99	LOVELAND	C	16220	.1265901	.1815755	83	112	.741
396	LARAMIE	W	24700	.1240875	.1747245	38	116	.328
956	SHERIDAN	W	10800	.1134501	.2278514	24	112	.214
142	STERLING	C	10636	.0981488	.2272663	60	80	.750
945	ROCK SPGS	W	12100	.0954183	.1308116	1	73	.014
57	GLENWOODSP	C	4106	.0873412	.0727686	12	12	1.000
401	ALLIANCE	N	6862	.0828684	.1078426	58	61	.951
46	FT MORGAN	C	7594	.0806381	.0744516	25	38	.658
657	VERNAL	U	3908	.0761402	.0181365	9	18	.500
208	BLACKFOOT	I	8716	.0748926	.1377385	28	62	.452
942	RIVERTON	W	7995	.0746413	.0648617	8	39	.205
41	ESTES PARK	C	1616	.0706671	.0233124	3	10	.300
347	LIVINGSTON	M	6883	.0679029	.0749742	21	55	.382
939	RAWLINS	W	7855	.0656501	.0918477	15	41	.366
441	SIDNEY	N	6403	.0656297	.1546060	23	48	.479
832	CODY	W	5161	.0655669	.0911520	1	46	.022
979	WORLAND	W	5055	.0628257	.0865262	4	33	.121
245	REXBURG	I	8272	.0573991	.0547677	7	41	.171
503	BELLEFCHE	S	4236	.0563135	.0781866	6	24	.250
850	EVANSTON	W	4462	.0533408	.1226920	12	26	.462
936	POWELL	W	4807	.0525357	.0518243	6	29	.207
515	DEADWOOD	S	2409	.0520822	.0682249	3	24	.125
27	CRAIG	C	4205	.0515969	.0588524	9	27	.333
410	CHADRON	N	5921	.0510043	.0614265	17	36	.472
968	TORRINGTON	W	4237	.0491142	.0778556	9	26	.346
895	LANDER	W	7125	.0480578	.0838286	17	42	.405
568	STURGIS	S	4536	.0470587	.1931133	7	66	.106
884	JACKSON	W	3196	.0465646	.0407412	3	30	.100
17	BRUSH	C	3377	.0441808	.0572896	24	15	1.600
424	KIMBLE	N	3680	.0434654	.0363854	2	19	.105
244	PRESTON	I	3310	.0418227	.0226634	0	15	.000

ID	CITY		POP	ECON INDEX	HEALTH INDEX	LPNS	RNS	LPNS/RNS
866	GREENRIVER	W	4196	.0411825	.0046478	0	12	.000
416	GERING	N	5639	.0409326	.0357896	28	62	.452
235	MONTPELIER	I	2604	.0405366	.0091119	0	9	.000
417	GORDAN	N	2106	.0382381	.0477490	7	13	.538
529	HOT SPRINGS	S	4434	.0371226	.1571159	19	45	.422
650	ROOSEVELT	U	2005	.0361758	.0383717	1	7	.143
567	SPEARFISH	S	4661	.0360387	.0641457	10	26	.385
141	STEAMBOAT	SC	2340	.0356374	.0496719	3	31	.097
367	RED LODGE	M	1844	.0355871	.0478323	9	13	.692
966	THERMOPLIS	W	3063	.0328478	.0718301	13	21	.619
620	HEBER	U	3245	.0327195	.0452927	12	13	.923
843	DOUGLAS	W	2677	.0328101	.0482217	3	14	.214
161	YUMA	C	2259	.0326000	.0317021	14	11	1.273
159	WRAY	C	1953	.0325489	.0419064	18	11	1.636
249	ST ANTHONY	I	2877	.0322569	.0251453	4	21	.190
133	RIFLE	C	2150	.0314549	.0423028	3	18	.167
976	WHEATLAND	W	2498	.0312253	.0485281	9	16	.563
340	HARDIN	M	2733	.0300822	.0411030	7	15	.467
820	BUFFALO	W	3394	.0280816	.0485182	7	21	.333
514	CUSTER	S	1597	.0279081	.0442960	0	16	.000
903	LOVELL	W	2371	.0276473	.0330638	1	11	.091
802	AFTON	W	1290	.0273228	.0269158	5	4	1.250
533	LEAD	S	5420	.0253528	.0602271	4	23	.174
924	NEWCASTLE	W	3432	.0242136	.0368194	7	16	.438
246	RIGBY	I	2293	.0243223	.0130138	2	20	.100
60	GRANBY	C	554	.0239858	.0064895	1	1	1.000
346	LAUREL	M	4454	.0236552	.0168873	14	39	.359
87	JULESBURG	C	1578	.0237085	.0352003	7	11	.636
889	KEMMERER	W	2292	.0225549	.0236191	5	8	.625
534	LEMMON	S	1997	.0221925	.0320243	4	12	.333
148	VAIL	C	484	.0218040	.0113315	0	11	.000
652	SMITHFIELD	U	3342	.0215054	.0072081	1	19	.053
434	MITCHELL	N	1842	.0206367	.0152343	21	21	1.000
407	BRIDGEPORT	N	1490	.0205651	.0277746	9	13	.692
311	BIG TIMBER	M	1592	.0201584	.0304053	1	2	.500
322	COLUMBUS	M	1173	.0195018	.0338759	10	13	.769
74	HOLYOKE	C	1640	.0197017	.0408889	10	16	.625
252	SODA SPGS	I	2977	.0188236	.0261320	8	13	.615
933	PINE BLUFF	W	937	.0183884	.0007937	0	1	.000
155	WINDSOR	C	1564	.0184266	.0127152	2	6	.333
79	IDAHO SPGS	C	2003	.0180543	.0088371	1	16	.062
1	AKRON	C	1775	.0181107	.0702016	11	9	1.222
216	DRIGGS	I	727	.0180798	.0261642	0	5	.000
383	W YELLWSTN	M	756	.0174377	.0004799	0	2	.000

APPENDIX "I"

RATIO OF PHYSICIANS TO 1,000 POPULATION

In this appendix the ratios of physicians per 1,000 population are ordered according to the magnitude of the economic index for the first six groups of communities.

ID	CITY		POP	ECON	HEALTH	PHYS/POP
31	DENVER	C	979991	5.00124	9.3977	2.5450
651	SALTLAKE C	U	557635	2.62146	3.13791	1.79329
312	BILLINGS	M	61581	.58468	.57461	1.86746
642	OGDEN	U	116945	.57777	.71324	1.36816
647	PROVO	U	110451	.51670	.83873	.97948
827	CASPER	W	39420	.38948	.31263	1.49746
14	BOULDER	C	69279	.38691	.58074	1.65995
559	RAPID CITY	S	43336	.34894	.56428	1.50561
224	IDAHOFALLS	I	35776	.31194	.3562	1.67715
243	POCATELLO	I	40036	.29437	.5228	1.34879
45	FT COLLINS	C	43337	.28988	.47981	1.59217
63	GREELEY	C	40127	.27060	.42653	1.86897
829	CHEYENNE	W	40500	.26298	.55235	1.67500
98	LONGMONT	C	23233	.18337	.25059	1.50854
440	SCOTTSBLUF	N	14507	.17120	.31606	1.72331
315	BOZEMAN	M	18671	.16674	.23605	1.98179
631	LOGAN	U	22333	.14410	.19429	1.52241
99	LOVELAND	C	16221	.12659	.18159	.80148
896	LARAMIE	W	2470	.12409	.17473	.97166
956	SHERIDAN	W	10809	.11345	.22785	1.48148
142	STERLING	C	10636	.09815	.22727	1.59834
945	ROCK SPGS	W	12100	.09542	.13081	.66116
57	GLENWOODSP	C	4106	.08734	.07277	1.70492
431	ALLIANCE	N	6862	.08287	.10784	1.45733
45	FT MORGAN	C	7594	.08064	.07445	1.05346
657	VERNAL	U	3908	.07614	.01814	1.27943
208	BLACKFOOT	I	8716	.07489	.18774	1.37678
942	RIVERTON	W	7995	.07464	.06486	.87555
41	ESTES PARK	C	1616	.07057	.02331	3.71287
347	LIVINGSTON	M	6883	.06790	.07497	1.16228
939	RAWLINS	W	7855	.06565	.04183	1.65505
441	SIDNEY	N	6403	.06563	.15461	.93706
832	CODY	W	5161	.06557	.09115	1.93761
979	WORLAND	W	5055	.06283	.08653	.79130
245	REXBURG	I	8272	.05740	.05477	.84623
503	BELLEFCHE	S	4236	.05631	.07819	.94429
850	EVANSTON	W	4462	.05334	.12269	2.24115
936	POWELL	W	4807	.05254	.05182	1.04015
515	DEADWOOD	S	2430	.05208	.0682	2.07555
27	CRAIG	C	4205	.05160	.05884	.00000
415	CHADRON	N	5921	.05100	.06143	.67556
968	TORRINGTON	W	4237	.04911	.07786	2.36016
895	LANDER	W	7125	.04806	.08383	1.40351
861	GILLETTE	W	7194	.04763	.07064	.69502
565	STURGIS	S	4536	.04706	.19311	.66138
884	JACKSON	W	3195	.04656	.04074	1.56446
17	BRUSH	C	3377	.04418	.05729	.88836
424	KIMBLE	N	3680	.04347	.03639	.81522
244	PRESTON	I	3310	.04182	.02266	.90634
966	GREENRIVER	W	4196	.04118	.00465	.47664

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416  GERING       N    5639   .04093   .03579   1.59603
235  MONTPELIER   I    2604   .04054   .00911   1.15207
417  GORDAN       N    2106   .03824   .04775   2.37417
529  HOT SPRINGSS      4434   .03712   .15712   1.57871
650  ROOSEVELT    U    2005   .03618   .03837   1.49626
567  SPEARFISH    S    4661   .03604   .06415    .64364
141  STEAMBOAT SC      2340   .03564   .04967   1.70940
367  RED LODGE    M    1844   .03559   .04783   1.08460
966  THERMOPLIS   W    3063   .03285   .07183   1.63239
620  HEBER        U    3245   .03272   .04529    .92450
943  DOUGLAS      W    2677   .03281   .04822    .74711
161  YUMA         C    2259   .03260   .03177    .88535
159  WRAY         C    1953   .03255   .04191   2.04813
249  ST ANTHONY   I    2877   .03226   .02515   1.04275
133  RIFLE        C    2150   .03145   .04231   1.39535
976  WHEATLAND    W    2498   .03123   .04853   1.20096
340  HARDIN       M    2733   .03008   .0411     .73180
820  BUFFALO      W    3394   .02808   .04852    .88391
514  CUSTER       S    1597   .02791   .04437   1.25235
903  LOVELL       W    2371   .02765   .03306   2.10882
802  AFTON        W    1290   .02732   .02692   1.55039
533  LEAD         S    5420   .02535   .06023    .92251
924  NEWCASTLE    W    3432   .02421   .03682    .87413
246  RIGBY        I    2293   .02432   .01301   1.30833
 60  GRANBY       C     554   .02399   .00649   1.80505
346  LAUREL       M    4454   .02366   .01689    .67355
 87  JULESBURG    C    1578   .02371   .03529   1.26743
889  KEMMERER     W    2292   .02255   .02362    .87260
534  LEMMON       S    1997   .02219   .03202   1.00150
148  VAIL         C     484   .02180   .01133   4.13223
652  SMITHFIELD U      3342   .02151   .00721    .59844
434  MITCHELL     N    1942   .02064   .01523   2.17155
407  BRIDGEPORT N      1490   .02057   .02777   1.34228
311  BIG TIMBER M      1592   .02016   .03041   1.25628
322  COLUMBUS     M    1173   .01950   .03388   1.70503
 74  HOLYOKE      C    1640   .01970   .04089   1.21951
252  SODA SPGS    I    2977   .01882   .02613    .67182
933  PINE BLUFF W       937   .01839   .00079   2.13447
155  WINDSOR      C    1564   .01843   .01272   1.27877
 79  IDAHO SPGS C      2003   .01805   .00884    .99850
  1  AKRON        C    1775   .01811   .07023    .00000
216  DRIGGS       I     727   .01808   .02616   1.37551
383  W YELLWSTN M       756   .01744   .00048    .00000
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